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EXPERIMENTAL INQUIRIES

INTO THE

LYMPHATIC SYSTEM.

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Experimental Inquiries:

PART THE SECOND.

CONTAINING

A DESCRIPTION
OF THE
LYMPHATIC SYSTEM
In the HUMAN SUBJECT,
And in OTHER ANIMALS.

ILLUSTRATED WITH PLATES.

Together with Obſervations on the LYMPH,
and the Changes which it undergoes
in ſome Diſeaſes.

By WILLIAM HEWSON, F. R. S.
AND TEACHER OF ANATOMY.

> *Atquè in anatomia corporum organicorum (qualia ſunt hominis & animalium) opera ſane recte & utiliter inſumitur; & videtur res ſubtilis & ſcrutinium naturæ bonum.*
>
> Lord BACON.

LONDON:
Printed for J. JOHNSON, No. 72, *St. Paul's Church Yard.*
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BENJAMIN FRANKLIN,

L. L. D. F. R. S.

S I R,

PERMIT me to dedicate this Eſſay to you, as a Tribute to your Genius which has deſervedly obtained you the firſt Place amongſt Philoſophers; and as a mark of Gratitude, for the many Acts of Friendſhip with which you have honoured,

Sir,

Your much obliged,

And moſt obedient

Humble Servant,

WILLIAM HEWSON.

PREFACE.

THE ſcience of anatomy has now been ſo long and ſo ſucceſsfully cultivated, that moſt parts of the human body have been both carefully deſcribed and accurately delineated; but the veſſels which are the ſubjects of this eſſay, having only of late been made known to anatomiſts, and not being eaſily traced by diſſection, have not been completely deſcribed, nor have they ever been delineated. The following, therefore, is an attempt, in ſome meaſure, to ſupply theſe deficiencies; and the author flatters himſelf, that when it is conſidered how great a ſhare thoſe veſſels have in the compoſition of our body, and how important

portant the offices are which they perform, that this ſmall addition to the ſtock of Anatomical Science will not be unacceptable, either to the practitioners of the healing art, or to the philoſophical inquirers into the works of nature.

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29	3	*for* extremeties *read* extremities
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OF THE LYMPHATIC SYSTEM.

CHAP. I.

A ſhort Hiſtory of the Diſcoveries made in the Lymphatic Syſtem.

SINCE the days of *Aſellius*, of *Rudbeck* and of *Bartholin*, who by their ſucceſsful inquiries firſt proved the exiſtence of thoſe veſſels in the human body which are now called the Lymphatic Syſtem, no part of anatomy has more engaged the attention of its profeſſors: partly from its being the largeſt field that has been lately opened for their cultivation, and partly from their being ſo thoroughly perſuaded of its great importance.

Aſellius in the year 1622, reaped the firſt laurels in this field, by his diſcovery of thoſe veſſels on the meſentery, which, from their carrying a milk-like fluid, he denominated lacteals†. This diſcovery being made by opening a living dog, anatomiſts were thence encouraged to make experiments on living animals; and *Pecquet*, on opening a dog in the year 1651, found a white fluid mixed with the blood in the right auricle of the heart. Suſpecting this fluid to be chyle, he endeavoured to determine how it got from the lacteals into the heart; this he found was by means of the *Ductus Thoracicus*, which he traced from the lacteals to the ſubclavian vein*, and thus he clearly proved the exiſtence of that duct which we now conſider as the trunk of the ſyſtem. Juſt before his time the lacteals had been ſuppoſed to terminate in the liver, conformably to the idea which the phyſiologiſts of that period had adopted about the uſe of this organ, which, from the authority of the older anatomiſts, they believed was the *Viſcus Hæmatopoeticum*, or received the chyle from the inteſtines to convert it into blood.

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† Aſellius de Lact.

* Pecquet Exp. Nova Anat. fig. 2d, in Hemſterhuis, Meſſe Aurea.

Next, *Rudbeck*, Anno. 1651,[†] Dr. *Jolyffe*[‡], and *Thomas Bartholin*, about the year 1652[||], diſcovered the other parts of this ſyſtem, which from their carrying a tranſparent and colourleſs fluid, are called the lymphatic veſſels. And thus there was proved to exiſt in an animal

[†] Ol. Rudb. Exercit. Anat. Cap. 1, in Hemſterhuis Meſſe Aurea.

[‡] Gliſſon de Hepate, cap. xxxi.

[§] Barthol. de Lacteis Thoracis, in Hemſterhuis Meſſe Aurea.

body a ſyſtem of ſmall veſſels carrying fluids very different from the blood, and opening into the ſanguiferous veſſels at the left ſubclavian vein.

To *Aſellius*, *Pecquet*, *Rudbeck*, *Jolyffe* and *Bartholin*, we are therefore indebted for the diſcovery of the different parts of this ſyſtem; not but that ſome of theſe veſſels had been ſeen and mentioned by their predeceſſors, but it was in too curſory a manner to give them any title to the diſcovery*.

After this period *Nuck* added to our knowledge of this ſyſtem by his injections of the lymphatic glands †, and

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* Thus the lacteals had been ſeen in kids by *Eraſiſtratus*, who calls them arteries, as we are informed by *Galen*. See Galen oper. Tom. 1, p. 61, edit. apud Junt.

The Thoracic Duct had been ſeen by *Euſtachius*, who ſpeaks of it as a vein of a particular kind. See Euſtachius de Vena ſine Pari.

† See his Adenographia.

Ruyſch by his deſcription of the valves of the lymphatic veſſels,* and Dr. *Meckel* by his accurate account of the whole ſyſtem, and by tracing thoſe veſſels in many parts where they had not before been deſcribed †.

Beſides theſe authors, Dr. *Hunter* and Dr. *Monro* have called the attention of the public to this part of anatomy, in their controverſy concerning the diſcovery of the office of the lymphatics.

When the lymphatic veſſels were firſt ſeen and traced into the thoracic duct, it was natural for anatomiſts to ſuſpect, that as the lacteals opened into the inteſtines to abſorb, the lymphatic veſſels, (which are branches of the ſame ſyſtem) might poſſibly do the ſame office with reſpect to other parts of the body; and accordingly Dr. *Gliſſon*, who wrote in

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* In his Delucidatio Valvularum.

† Epiſtola ad Hallerum.

1654 (that is, the very year after *Bartholine* publiſhed on the lymphatic veſſels) ſuppoſes theſe veſſels aroſe from cavities, and that their uſe was to abſorb; and *Frederic Hoffman* has very explicitly laid down the doctrine of the lymphatic veſſels being a ſyſtem of abſorbents*. But anatomiſts in general have been of a contrary opinion; for from experiments, particularly ſuch as were made by injections, they have been perſuaded that the lymphatic veſſels did not ariſe from cavities, and did not abſorb, but merely were continued from ſmall arteries. The doctrine therefore that the lymphatics like the lacteals, were abſorbents, as had been ſuggeſted by *Gliſſon* and by *Hoffman*, has been revived by Dr. *Hunter* and Dr. *Monro*, who have controverted the experiments of their predeceſſors in anatomy, and have endeavoured to prove that the lymphatic veſſels are not continued from arteries, but are abſorbents.

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* See below, chap. 10.

To this doctrine however many and ſtrong objections have been ſtarted, particularly by the learned M. *de Haller*[*], and it has been found, that before the doctrine of the lymphatics being a ſyſtem of abſorbents can be eſtabliſhed on a ſolid foundation, it muſt firſt be determined, whether other animals, beſides man and quadrupeds, have or have not this ſyſtem. I have been ſo fortunate as to prove the affirmative of this queſtion, by diſcovering the Lymphatic Syſtem in birds, fiſh, and amphibious animals[†], and in conſequence of theſe diſcoveries I have alſo arrived at the knowledge of conſiderable varieties in the compoſition of thoſe veſſels through the various claſſes of animals; by comparing this knowledge with ſome facts that I have lately obſerved concerning the blood, I have thence been led to aſcertain the uſe of the lymphatic glands, the thymus, and the ſpleen; which have ſo long been conſidered as the *opprobria* of anatomiſts.

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[*] Elem. Phyſ. lib. xxiv, ſect. 2, 3.

[†] Accounts of which have already been publiſhed in the Phil. Tranſactions, vol. 58 and 59.

Theſe laſt obſervations I propoſe making the ſubject of a future publication*; but in order to prepare the reader for it, I have thought it neceſſary to lay before him a deſcription and compariſon of the lymphatic veſſels in different animals. And that this may be the more worthy his attention, I have not only traced thoſe veſſels in moſt parts of the human body as Dr. *Meckel* has done, but I have obſerved ſome circumſtances which had eſcaped his notice; and I have illuſtrated the deſcription with plates, the neceſſity of which has appeared ſo ſtrongly to ſome who have preceded me in this ſubject, particularly to Meſſ. *Monro*, *Meckel* and *Hunter*, that they have each promiſed to ſupply the deficiency, but none of them having yet done it, I have undertaken the taſk myſelf, that I may be able to refer the reader to the facts from which my concluſions are made.

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* An abſtract of theſe diſcoveries, though an imperfect one, has been publiſhed in the medical commentaries of Edinburgh, No. 1ſt, but without my concurrence.

CHAP. II.

A general Account of the Lymphatic Syſtem.

THE lymphatic ſyſtem conſiſts of the lacteals, the lymphatic veſſels, their common trunk the thoracic duct, and the glands called conglobate.

The lacteals begin from the inteſtinal tube, and can readily be ſeen in a dog or other quadruped that is killed two or three hours after eating, when they appear filled with a white chyle. The experiment ſucceeds beſt when the dog is fed with milk: but they do not always convey a white fluid, for, even in the dog, if opened long after a meal, they are found diſtended with a liquor that is tranſparent and colourleſs like the lymph; and in birds I have never found the chyle white but always tranſparent and limpid; theſe veſſels therefore might, with as much propriety, be called the lymphatics of the inteſtines.

The lymphatic veſſels are ſmall pellucid tubes that have now been diſcovered in moſt parts of the human body; the fluid they contain is generally as colourleſs as water, a circumſtance which procured them at firſt the name of *Ductus Aquoſi**, and afterwards that of *Vaſa Lymphatica* †. The courſe of the lymph, like that of the chyle, is from the extreme parts of the body towards the centre, and the lymphatic veſſels commonly lie cloſe to the large blood veſſels. If therefore a ligature be made round the large blood veſſels of the extremities of a living animal, or of one juſt dead, that ligature, by embracing the lymphatics, will ſtop the courſe of the lymph, which by diſtending the veſſels will make them viſible below the ligature.

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* See Rudbeck, l, c.

† See Bartholin, l, c.

All the lacteals and moſt of the lymphatic veſſels open into the thoracic duct, which lies upon the ſpine and runs up towards the neck of the animal, where it commonly opens into the angle between the jugular and ſubclavian veins of the left ſide; and thus both the chyle and lymph are mixed with the blood. If therefore the thoracic duct be tied inſtantly after killing an animal, not only the lacteals, but alſo the lymphatics in the abdomen and lower extremities become diſtended with their natural fluids; the courſe of thoſe fluids being ſtopt by the ligature.

The lacteals, the lymphatics, and the thoracic duct, all agree in having their coats more thin, and more pellucid than thoſe of the blood veſſels. But although their coats are ſo thin they are very ſtrong, as we daily ſee on injecting them with mercury, ſince they reſiſt a column of that fluid, whoſe weight would make it burſt through blood veſſels, the coats of which are many times thicker than thoſe of the lymphatic ſyſtem.

The thinneſs of the coats prevents our dividing them from one another, and thereby aſcertaining their number as we do thoſe of the blood veſſels. But as the blood veſſels have a denſe internal coat to prevent tranſudation, we have reaſon to believe the lymphatics have the ſame. And as the blood veſſels have a muſcular coat, which aſſiſts in the circulation*, ſo may the lymphatics, as is rendered probable from what Dr. *Haller* ſays of his having found them irritable in his experi-

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* The exiſtence of the muſcular coat of the blood veſſels has been rendered probable by Dr. Verſchuir's experiments, wherein theſe veſſels were

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found to be irritable, and alſo by the following circumſtance which I obſerved in diſſecting an aſs. The arteries of this, like thoſe of other animals, have a ſtrong elaſtic coat, which coat after diſtention contracts them again to a certain degree; but this contraction never goes ſo far as to ſhut up the cavity of the artery, and as it acts equally in the dead as in the living body, large arteries are therefore always found with conſiderable cavities. But in this aſs, which I bled to death, the arteries contracted more than their elaſtic coats were capable of doing; for thoſe of the kidneys were without a cavity and reſembled a cord; and that this contraction was muſcular appeared upon diſtending them again, in which caſe they ſtood open as they commonly do in dead bodies. This fact will help us to explain why the arteries appear empty in dead bodies; which may be owing to their muſcular fibres having (before death) contracted to the degree ſeen in this animal, by which means all the blood was driven into the veins; but theſe muſcular fibres ceaſing to act after death, the elaſtic fi-

bres

ments[†], and alſo from what is obſerved on ſeeing them in living animals diſtended with their lymph, in which caſe they appear of a conſiderable ſize; but upon emptying them of their contents, they contract ſo much as not to be eaſily diſtinguiſhed. This is an experiment which I have frequently made in the trunk of the lacteals in a gooſe and on the lymphatic veſſel on its neck, both of which when diſtended with their natural fluids are as large as a crow quill; but on emptying them in the living animal, I have ſeen them contract ſo much that it was with the greateſt difficulty

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bres overcome that contraction, and expand the arteries which therefore appear empty.

Since writing the above, I have diſſected a ſtill-born child which was defective in many parts of the body, and in particular in having no heart. In this child the circulation had been carried on merely by an artery and a vein, whoſe coats therefore probably were muſcular.

[†] Sur le Mouv. du Sang, Ex. 295, 298.

I could diſtinguiſh them from the fibres[†].

The coats of lymphatic veſſels have, in common with all other parts of the body, arteries and veins for their nouriſhment; this is rendered probable by their being ſuſceptible of inflammation, for they are frequently found in the form of a cord, painful to the touch, and extending from an ulcer to the next lymphatic gland; inſtances of which are mentioned below[*]. Theſe painful ſwellings of lymphatic veſſels likewiſe ſhew that their coats have ſenſibility, and therefore that they have nerves as well as arteries and veins.

[†] See alſo Haller, El. Phyſ. Lib. 2, ſect. 3. § iii. The celebrated Nuck thought he could ſeparate the coats of the lymphatics, Adenograph, cap. iii.

[*] Chap. 13.

The lymphatic ſyſtem in moſt animals, but particularly in man and quadrupeds, is full of valves. Theſe valves have been painted by the celebrated *Nuck*, *Ruyſch* and others, and are much more frequent than in the common veins, and thence theſe lymphatics have ſometimes been diſtinguiſhed by the name of valvular lymphatic veſſels. Thoſe valves are generally two in number, are of a ſemilunar ſhape, and the one is ſometimes much larger than the other. In moſt parts of the body theſe valves are ſo numerous, that there are three or four pair in an inch of ſpace, but ſometimes there is no more than one pair. They are leſs numerous in the thoracic duct than in the branches of the ſyſtem; thence it might be ſuppoſed, that in proportion as we go from the trunk to the branches, we ſhould find them thicker ſet: but this is not always true, for I have obſerved them more numerous in the lymphatic veſſels of the thigh, than on thoſe of the leg. When the veſſels are diſtended with lymph they appear larger where the valves are; which ſometimes gives a lymphatic veſſel an appearance of being made of a chain of veſicles; as ſuch they are repreſented by ſome authors*: But it is an appearance that very ſeldom occurs; the reader will not obſerve it in any of the plates which are here laid before him.

Laſtly the lymphatic ſyſtem, in different parts of its courſe, has the glands called conglobate, or lymphatic. Theſe glands are ſo placed that the veſſels come in on one ſide, and paſs out on the other, in their way to the thoracic duct. Before the diſcovery of the lymphatic veſſels in birds, fiſh and turtle, ſome anatomiſts have conſidered theſe glands as ſo eſſentially neceſſary to the lymphatic ſyſtem, that they have generally ſet about diſcovering the veſſels by firſt looking for thoſe glands; and wherever they found glands, they pronounced that there muſt be veſſels, and when no glands could be ſeen, they thought it as certain a proof of there being no veſſels. But as we know they are wanting in ſome animals, I ſhall not take notice of their ſtructure and uſe in this chapter; but ſhall ſpeak of them in a future publication, where I ſhall treat of the ſpleen and thymus, with which they are connected in their office.

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* See Nuck's Adenographia.

C H A P. III.

A particular Deſcription of the Lymphatic Syſtem in the Human Body.

IT has already been obſerved, that the lymphatic ſyſtem, beſides the glands, is divided into three parts, viz. The lacteals, the lymphatic veſſels, and the thoracic duct. That the lacteals belong to the inteſtinal tube, whilſt the lymphatic veſſels belong to all the other parts of the body, and that the thoracic duct is the common trunk which receives both the lacteals and the lymphatics. I ſhall next proceed to give a particular deſcription of each of theſe veſſels, and ſhall begin with the lymphatics of the lower extremities.

The lymphatic veſſels of the lower extremities may be divided into two ſets, viz. a ſuperficial, and a deep ſeated.

The ſuperficial ſet of lymphatics conſiſts of a conſiderable number of veſſels that lie between the ſkin and the muſcles, and belong to the ſurface of the body, or the ſkin, and to the cellular membrane which lies immediately under it. Of theſe there are two large branches that can be readily enough diſcovered in the limbs of dropſical ſubjects. One of which runs upon the top of the foot as is repreſented *Plate* 1. (a) another can generally be found juſt under the inner ankle. I have introduced pipes into both of them, and have thereby filled them the whole length of the lower extremity, as is ſeen in *Plate* 1.

The lymphatic (a) * which belongs to the toes, runs up on the outſide of the

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* The ſmall letters refer to the outlines; the capitals to the figure itſelf, which therefore the reader is requeſted to examine after viewing the outlines

the tendon of the *tibalis anticus* (I), till it has got above the ankle; and it divides at (b) and again at (c,c,c) forming a *plexus*, which runs over the ſhin bone, (H) and aſcends in the cellular membrane immediately under the ſhin between that bone and the internal belly of the *gaſtrochnemius* (G) to the inſide of the knee (F) where in this figure it diſappears, but may be ſeen in *Plate* 2. This plexus, having paſſed the inſide of the knee, appears upon the thigh immediately under the ſkin, and over all the muſcles, as is ſeen in *Plate* 1. (e), from which it paſſes to the groin, where theſe veſſels enter the lymphatic glands.

The lymphatic glands of the groin are ſix, ſeven, or eight in number; of theſe ſome lie in the very angle between the thigh and the abdomen, and others lie a few inches down, on the fore part of the thigh. The lymphatic veſſels, above deſcribed, enter the lowermoſt of theſe glands, which is the ſubject of this plate are four in number, viz. (f,f, g,g): one branch however avoids theſe glands as at (h), which afterwards bends over at (i) to the gland (k); from which go veſſels to the other lymphatic glands (l,l) that lie in the angle between the thigh and the abdomen. It is into theſe upper glands alone that the lymphatic veſſels of the genitals enter, ſo that the venereal bubo which ariſes in conſequence of an abſorption of matter from theſe organs, is always ſeated in thoſe upper glands, and the lower glands (f,f, g,g,) are never affected, except by the regurgitation of the matter, or from their vicinity to the glands firſt diſeaſed, which very ſeldom happens. And, as it is the upper glands that are affected by the abſorption of matter from the genitals, ſo it is the lower which are commonly firſt affected from the abſorption of the acrid matter of an ulcer, diſeaſed joint, carious bone, (in the parts below theſe glands,) a circumſtance that may aſſiſt us in the *diagnoſis* of thoſe two kinds of buboes: Remembering however that this rule may be liable to an exception from one of the lymphatic veſſels paſſing the lower glands, and only entering the upper, as is ſeen at (h) in the ſame plate.

The lymphatic veſſels of the genitals having joined thoſe of the thigh, a network is formed, which enters the abdomen under the edge of the tendon of the external oblique muſcle, called pouparts ligament, one of theſe veſſels is ſeen in *Plate* 3. *(b,b.)* This *plexus* on the inſide of pouparts ligament conſiſts of many branches, ſome of which embrace the illiac artery, of which one is ſeen in *Plate* 3. at *(c,c.)* but the greateſt

eſt number of them paſs up in the inſide of the artery, as is ſeen at (m n) in *Plate* 1. and at *(c,c.) Plate* 3.

Theſe ſuperficial lymphatics, ſmall as they are, * probably are the trunks of thoſe veſſels which abſorb from the ſkin and the cellular membrane immediately under it; and as no conſiderable branches can be diſtinguiſhed on the outſide of the leg or thigh, it is probable that all the lymphatic veſſels of thoſe parts bend towards the inſide, and open into the trunks that are here repreſented.

Upon theſe veſſels, from the foot to the groin, there is commonly not one lymphatic gland. But this rule has likewiſe ſome exceptions, for, even at the lower part of the leg, there is a very ſmall one in the ſubject from which this plate was taken; it is repreſented at (d) *Plate* 1: and in another ſubject I ſaw a ſmall lymphatic gland near (e), but theſe, I believe, ſeldom occur; however they lead to this concluſion, that the lymphatic glands even in the human body, are in number and ſituation a little different in different ſubjects.

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* With reſpect to the ſize of theſe lymphatics, it is neceſſary to obſerve, that although the limb is repreſented in this plate about a third of the natural ſize, yet the artiſt could not expreſs the lymphatic veſſels to the ſame ſcale, ſo that all of them appear larger than they ought to be in proportion to the magnitude of the limb.

Beſides theſe ſuperficial lymphatic veſſels which lie above all the muſcles, or in the cellular membrane under the ſkin, there is a ſet deeper ſeated that lie amongſt the muſcles and accompany the crural artery of theſe the principal trunk can be diſcovered by cutting down to the poſterior tibial artery, near the inner ankle; I have introduced a pipe into it at this part and have injected it in ſeveral ſubjects, one of which is repreſented *Plate* 2.

From the inner ankle at (a,) this veſſel paſſes up along with the poſterior tibial artery, being hid amongſt the muſcles on the back part of the *tibia*. About the middle of the leg it enters a ſmall gland at (c), and as I have ſeen this gland in ſeveral ſubjects, I ſuſpect it will be commonly found. Having paſſed through this gland the lymphatic runs up to the back part of the ham, ſtill lying cloſe to the artery, and in the ham it paſſes through three glands, *viz.* (f, g, h). I have ſeen a ſubject in which I could find only two glands, ſo that I ſuſpect the number varies. Hitherto this lymphatic has been a ſingle trunk; but after it has paſſed theſe glands it commonly divides into two or three branches, which ſtill accompany the crural artery, and paſs with it through the perforation in the *triceps* muſcle. This muſcle is divided in the preparation from which this figure was taken, in order to give a better view of the lymphatics; and the cut ends of the muſcle appear at (F, F), though not very diſtinctly, from their being ſhrunk by drying. The lymphatic veſſels having perforated the *triceps*, paſs up with the artery, as is ſeen at (k, l.) and enter a gland (m) which is deeper ſeated than thoſe which appear in the groin in *Plate* 1; from this gland they paſs into the ſuperficial glands, repreſented in *Plate* 1ſt (f,f, g,g) where the lymph of the deep ſeated, and of the ſuperficial lymphatics is mixed, and is conveyed into the body by the veſſels ſeen juſt above in the ſame plate. At this part likewiſe the lymph from the genitals is mixed with that brought by the two ſets of lymphatics from the lower extremities; and the whole enters the abdomen by the *plexus* of veſſels repreſented *Plate* 1, at (m), and a part of it at *Plate* 3 *(c)*.

The lymphatics of the lower extremeties having now reached the trunk of the body, and having paſſed under pouparts ligament, appear upon the ſides of the *oſſa pubis* near the pelvis at *(c, c) Plate* 3. A part of them paſſes up along with the illiac artery upon the brim of the *pelvis*, and another part dips down into the cavity of the *pelvis*, and joins the internal illiac artery near the ſciatic notch. At this place they are joined by the lymphatics from the contents of the *pelvis*, particularly from the bladder and the *veſiculæ ſeminales* in the male, and from the *uterus* in the female, and there are likewiſe a few branches which paſs through the ſciatic notch from the neighbourhood of the *glutei* muſcles. The lymphatic veſſels of the *uterus*, like its blood veſſels, are much enlarged, and therefore eaſily diſtinguiſhed, in the pregnant ſtate of that organ. At this part, where ſo many lymphatic veſſels join, there is commonly one or two glands.

Beſides thoſe lymphatic veſſels which dip down into the cavity of the *pelvis* on the inſide of the external illiac artery at *(c,c) Plate* 3*, there are others which keep on the outſide of that artery upon the *pſoas* muſcle, ſome of which are ſeen on the left ſide in the ſame plate at *(d;)* of theſe one part paſſes up to the loins at *(h,)* and goes under the *Aorta* in different branches, getting from the left ſide to the right, and joining the thoracic duct. Another part paſſes under the illiac arteries and appears upon the *os ſacrum* at *(f)*, making a beautiful network, joining the lymphatics of the right ſide, and paſſing under the right illiac artery, to form the network *(g)* upon the upper part of the right *pſoas* muſcle. In different parts of this courſe from pouparts ligament to the loins, and alſo in the loins themſelves there are, in moſt ſubjects, many lymphatic glands; none of which were filled in the ſubject from which this plate was made.

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* The letters of reference are very ſmall on this plate, and the reader it is hoped will excuſe the trouble it may give him to obſerve them.

The lymphatic veſſels of the right ſide, joined by ſome from the left, having now reached the right lumbar region, appear there in the form of a *plexus* of large veſſels, and paſs through ſeveral glands, which in this ſubject occupied the ſpaces *(i,i,i)*, but not being injected with mercury are not repreſented; at this part likewiſe they receive large branches, under the aorta, from the *plexus* on the left ſide of the loins, as is mentioned before; and having at laſt got up as high as the ſecond lumbar *vertebra*, they all join, and form a ſingle trunk called the thoracic duct, which is ſeen at *(m) Plate* 3. At this part they are likewiſe joined by the lacteals, which I ſhall next deſcribe.

The lacteal veſſels, ſo called from their commonly conveying a fluid that is of the colour of milk, begin from the inner ſurface of the inteſtines, where they have patulous orifices deſtined to imbibe the nutritious fluid or chyle: From the cavity of the inteſtines theſe veſſels paſs obliquely through their coats, uniting as they go ſo as to form larger branches. Theſe branches run on the outſide of the gut to get to that part which is next the meſentery; and, whilſt they are yet upon the gut, they are ſometimes of a ſize ſufficient to admit a ſmall pipe, ſo that I have injected them with mercury even in the human ſubject.

From the inteſtines they run along the meſentery and *meſocolon*, towards the ſpine; and in their way they paſs through the conglobate or meſenteric glands, which in the human ſubject are very numerous. Theſe glands divide the lacteals into two regions, for from the inteſtines to the glands theſe veſſels are called *lactea primi generis*, and from the glands to the thoracic duct, *lactea ſecundi generis*.

The lacteals of the ſmall inteſtines, as they run upon the meſentery, commonly accompany the ſuperior meſenteric artery, and unite, as they go on, into larger branches, ſo that by the time they have reached the root of the meſentery, they are of a conſiderable ſize, as may be ſeen in *Plate* 3. at *(k)*: From the meſenteric artery they paſs down by the ſides of the *aorta*, and open into the thoracic duct, as is ſeen at *(m)*. Whilſt the lacteals, or rather the lymphatics of the large inteſtines, accompany the inferior meſenteric artery, and open into the large lymphatic veſſels near its root.*

Into the thoracic duct at *(m)*, likewiſe enters the lymph of the other *viſcera* contained in the *abdomen*. This lymph is brought by a number of veſſels; a *plexus* of which may be traced from each kidney, lying principally behind the emulgent artery, and opening into the large lymphatic veſſels near the *aorta*: with theſe likewiſe go the lymphatics of the *glandulæ renales*, or renal *capſulæ*, as they are called.

The lymphatic veſſels of the ſpleen paſs from the concave ſide of that *viſcus*, along with the ſplenic artery in the ſinuoſity of the *pancreas*, by the lymphatic veſſels of which they probably are joined.

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* The lymphatic veſſels ariſe even from the *rectum*, as can be ſeen in quadrupeds that are opened immediately after death; or in fiſh when a coloured injection is thrown into their lymphatic ſyſtem.

The ſtomach has two ſets of lymphatic veſſels, the one running upon its leſſer, and the other upon its greater curvature; that which belongs to its leſſer curvature accompanies the coronary artery, and paſſes through ſome lymphatic glands that lie by its ſides. The other ſet of lymphatic veſſels paſſes from the great curvature of the ſtomach, through ſome lymphatic glands that lie cloſe to the *arteria gaſtrica dextra*; and deſcending by the *pylorus*, meets the *plexus* that accompanied the coronary artery; and near the leſſer curvature of the *duodenum*, forms a conſiderable network; into which not only the lymphatics from the ſpleen enter, but likewiſe thoſe from the gall bladder; and thoſe of the liver, which are very numerous, both in its convex and on its concave ſide. * From this net-work go ſome branches under the *duodenum,* and others over it, theſe branches open into the thoracic duct, near the termination of the large trunk of the lacteals, as ſeen at *(m) Plate* 3. The thoracic duct therefore is the common trunk which receives the lymphatic veſſels of the lower extremities, the lacteals, and the lymphatics of all the *abdominal viſcera.*

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* The lymphatic veſſels of the liver are painted by *Nuck* in his *Adenographia*, p. 64.

With reſpect to the lymphatics of the larger *viſcera,* (ſuch as, the liver, the ſpleen, and the kidneys,) they are generally in two ſets: one which lies upon the ſurface of the organ, and the other which accompanies the large blood veſſels in its center In the liver I have found theſe two ſets communicate with each other, ſo that by injecting mercury into the lymphatic veſſels which lie upon its convex ſurface, I have filled thoſe which accompany the *pori bilarii* and *vena portarum* in its center. The greateſt part of the lymphatic veſſels which lie upon the convex ſurface of the liver, run towards its falciform ligament, and paſs down by the ſide of the *vena cava*. But ſome of them run towards the right ligament of the liver, where they paſs down upon the diaphragm to get to the thoracic duct. The lymphatics on the concave ſurface run towards the *portæ* where they join thoſe which come from the center of the liver along with its large blood veſſels; It is remarkable of thoſe lymphatic veſſels which run upon the ſurface of the liver, that their valves can readily be made to give way, ſo that I have injected them from their trunks to their branches, and to great minuteneſs; ſome preparations of which I have now by me.

It has been ſuggeſted by one of the beſt anatomiſts of this age*, that the lymphatics of the ſtomach do not open into the thoracic duct like thoſe of the other *viſcera*, but only open into the ſanguiferous veins of the ſtomach; but from repeated diſſections of the human ſubject I am convinced of the contrary; and likewiſe from the analogy with other animals, particularly fiſh, whoſe lymphatic veſſels either have no valves, or the valves readily give way, ſo that I have repeatedly puſhed injections from the thoracic duct into the lymphatics of their ſtomachs, as I have alſo done into the lymphatics of the other *viſcera* contained in the cavity of their abdomen; as will be more particularly mentioned hereafter.

The thoracic duct, which receives all the veſſels that we have yet deſcribed, differs in its ſize in different ſubjects, but is always ſmaller in its middle than at its beginning, as is ſeen in *Plate* 3. Sometimes its lower part at *(m)* is ſtill larger in proportion than is there repreſented, and that enlargement has been called the *receptaculum chyli*, and is conſiderable in ſome quadrupeds, in turtle, and in fiſh: but many anatomiſts have denied that there is any part of the thoracic duct in the human ſubject that deſerves the name of *receptaculum*, and my experience makes me ſubſcribe to their opinion, as I have never ſeen any thing like a pyriform bag, as it has been deſcribed, but merely an enlargement not unlike a *varix*, and that only in few ſubjects: for commonly it appears, as in this plate, only a little larger than at its middle. This lower extremity of the thoracic duct is formed by the union of two, three, or four very large trunks of lymphatic veſſels:

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* Dr. Meckel.

Theſe large veſſels unite ſo as to form the duct about the lower part of the firſt, or the upper part of the ſecond *vertebra lumborum*, reckoning downwards.

Theſe large lymphatic trunks which form the thoracic duct are ſpread out upon the ſpine, thoſe of the right ſide lying below the right *crus diaphragmatis*, and thoſe of the left paſſing between the *aorta* and the ſpine; whilſt the thoracic duct itſelf lies on the right ſide of the *aorta*, between that artery and the right *crus diaphragmatis*, and behind the emulgent artery of the right ſide, as is ſeen *Plate* 3 at *(n)*. From this part it paſſes upwards, being at firſt covered by the *crus diaphragmatis*, and afterwards appears at *(o)* in the *thorax*, upon the ſpine between the *aorta* and the *vena azygos*. In the *thorax* it receives ſome lymphatics from the intercoſtal ſpaces; a few of which are ſeen at *(p)* and afterwards it receives veſſels from the lungs.

The lymphatics of the lungs are in two ſets, one of which paſſes on the poſterior part of each lobe by its root, into the thoracic duct near the middle of the thorax; and another ſet paſſes from the fore part of each lobe up towards the jugular and ſubclavian veins. Some of the lymphatics on the poſterior part of the left lobe paſs under the *aorta* to get to the thoracic duct.

At the root of the lungs, where the large blood veſſels enter, are many glands called bronchial, they are generally of a blackiſh colour in the human ſubject, and have been ſuſpected to ſecrete the *mucus* which is ſpit up from the *trachea*; but I have more than once diſtinctly filled them with mercury by injecting the lymphatic veſſels of the lungs, and therefore it is evident that they are not mucous but lymphatic glands.

The lymphatic veſſels from the anterior part of the left lobe of the lungs paſs into the angle between the jugular and ſubclavian vein of the ſame ſide, joining the thoracic duct at its termination, whilſt thoſe from the fore part of the right lobe do not communicate with the thoracic duct, but paſs into the angle between the right jugular and the right ſubclavian vein. Theſe lymphatics from the anterior parts of the lungs are probably accompanied by thoſe of the heart, which are repreſented by the accurate *Nuck* in his *Adenographia, fig.* XLI.

The thoracic duct, after receiving the veſſels before mentioned, paſſes behind the aſcending *aorta*, ſee *Plate* iv. and goes to the left ſide, terminating in the angle between the jugular and the ſubclavian vein. But, juſt before its termination, it generally goes higher up than the angle, and then bends down towards it, as is ſeen, *Plate* iv, *(b, c)*. Sometimes there are two thoracic ducts inſtead of one, but this rarely occurs in the human ſubject, but it is not unfrequent for the duct to ſplit near the upper part of the *thorax*, and the two branches, after ſpreading out from one another, commonly unite again at their termination in the angle between the left jugular and ſubclavian veins. I never ſaw any part of the thoracic duct terminate in the right ſubclavian of the human body, though ſuch a circumſtance has been obſerved by others *. But I have now by me a preparation where the duct ſplits at the upper part of the *thorax* into two branches, one of which enters the angle between the jugular and ſubclavian of the left ſide, and the other opens into the left ſubclavian vein, about half an inch on the outſide of that angle.

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* Dr. Meckel, Epiſt. ad Hallerum, p. 30.

In the deſcription of the lymphatic veſſels which lie near the ſpine, I have mentioned only a few glands, and in *Plate* 3, where thoſe veſſels are exhibited no glands are repreſented. This I at firſt conſidered as an imperfection in the preparation, and had intended to make a drawing from another, but there are two reaſons which have induced me to lay the preſent one before the reader. Firſt, the lymphatic glands are not conſtant, either in number or ſituation; and therefore the deſcribing them particularly in any one ſubject is leſs neceſſary, ſince we cannot be ſure of finding them exactly the ſame in any other. Secondly, the injecting the lymphatic veſſels from the groin to the neck, without filling one lymphatic gland, proves a fact which is contradictory to the received opinion concerning thoſe veſſels, viz. that they always paſs through glands in their way to the blood veſſels, ſo that if theſe glands were obſtructed, a dropſy muſt be an inevitable conſequence, which is not ſtrictly true when we ſpeak of the lymphatic veſſels in the *abdomen*, where, I find, beſides the veſſels which go into the glands, there are generally ſome which eſcape them. The ſame is true with reſpect to the lacteals, ſo that an obſtruction of the meſenteric glands may not always produce a *maraſmus*, as a part of the chyle may paſs the glands and get into the thoracic duct.

But although no lymphatic glands are repreſented in this plate, it may be neceſſary to mention where they are commonly ſeen.

The meſentery of the human ſubject is well known to contain a conſiderable number of them; they are likewiſe found in the *meſocolon* where the lymphatics of the large inteſtines paſs through them. The ſtomach has alſo ſeveral glands which belong to its lymphatic veſſels, and lie near the *arteria coronaria*, and the *gaſtrica dextra*. There are likewiſe a few upon the *omentum* in ſome ſubjects, and there are alſo many glands by the ſides of the *pancreas*, particularly near the leſſer lobe of that *viſcus*, cloſe to the *duodenum*.

Beſides theſe glands which belong to the inteſtinal tube, there are many more in the cavity of the *abdomen*, and a few in the cavity of the *pelvis*, which belong to the lymphatic veſſels of the other organs.

There is commonly a pretty conſiderable gland ſeen juſt on the inſide of the edge of the tendon of the external oblique muſcle, called pouparts ligament, on the outſide of the illiac artery; and there are others near that artery, where it lies upon the *pſoas* muſcle. There are likewiſe commonly one or two near the internal illiac artery in the cavity of the *pelvis*, and there is a conſiderable number generally met with by the ſides, and upon the lumbar *vertebræ*. In the ſubject from which I took *Plate* 3. the ſpaces *(i,i,i,i)* were occupied by ſuch glands, which were not injected, and therefore are not repreſented in that plate.

Near the ſpleen, liver, kidneys, and renal *capſulæ*, there are alſo lymphatic glands which belong to the lymphatic veſſels of theſe organs.

There are likewiſe lymphatic glands ſometimes obſerved by the ſides of the thoracic duct, particularly about the middle of the *thorax*, which glands belong principally to the veſſels of the lungs.

There are alſo many lymphatic glands (called bronchial) near the root of the lungs, theſe glands are placed upon the lymphatic veſſels, juſt where they quit the lungs. But no lymphatic glands have yet been obſerved in the ſubſtance of the lungs, and the tubercles which ſome ſuſpect to be obſtructed lymphatic glands, ſeem to have a different origin. There are likewiſe ſome glands ſeen on the lymphatic veſſels which lie near the ſubclavian veins at the upper part of .he *thorax*, and which belong to the fore part of the lungs.

Beſides theſe there are ſome lymphatic glands upon the *aorta* near the *æſophagus*, and there are alſo others occaſionally met with in the intercoſtal ſpaces, and there are generally two or three contiguous to the thoracic duct at the lower part of the neck and upper part of the *thorax*, near the termination of that duct, in the angle between the left jugular and the left ſubclavian vein.

Having thus traced the lymphatic ſyſtem in all parts of the body that are below the termination of the thoracic duct, I ſhall next examine that part of it which lies upon the head, neck, and upper extremities, where the tracing it is attended with greater difficulties.

By the ſide of each internal jugular vein is a large lymphatic veſſel, which is the trunk of thoſe of one ſide of the head and neck, that of the right ſide is ſeen *Plate* IV. (*l*). There are likewiſe ſmaller lymphatics which are ſeen near the branches of the external carotid artery. There are alſo lymphatic glands by the ſides of the parotid and maxillary glands, and by the ſides of the large artery where it lies upon the chin, and by the ſide of the occipital artery; and I have ſeen one upon the root of the maſtoid proceſs of the *os temporis*. Thoſe glands, which accompany the lower part of the artery that runs upon the face, are ſometimes ſwelled in conſequence of abſorption from the lips and the parts adjacent, and alſo from gum-boils; and thoſe which accompany the occipital artery are frequently enlarged in conſequence of the abſorption of matter from wounds of the ſcalp; from which facts it is evident that the external parts of the head are ſupplied with lymphatic veſſels. In quadrupeds I have diſtinctly ſeen thoſe veſſels, particularly in a dog and in an aſs, by paſſing a ligature round the large blood veſſels of their necks immediately after killing thoſe animals. Theſe experiments I made with a view to determine whether the brain had lymphatic veſſels, but I never yet have been able to ſee any on that organ; neither when I tied up the lymphatics on the necks of thoſe animals, and thereby ſtopt the courſe of the lymph; nor when I diſſected the human brain, which I have carefully done ſeveral times with the view to diſcover thoſe veſſels, and have particularly ſought for them in the *plexus choroides* where they have been ſuſpected to be ſeen, and near the *glandula pituitaria* which is ſuppoſed by ſome to be a lymphatic gland, but improperly, ſince neither that gland nor the *glandula pinealis* agrees with the lymphatic glands, as I ſhall ſhew in the third part of theſe inquiries.

But although lymphatic veſſels have not yet been demonſtrated in the brain, it is probable from analogy, that this organ is not deſtitute of them; and the following caſe affords an argument in favour of abſorption being carried on here by lymphatics, as well as on other parts of the body.

J. H. a young man of twenty five years of age, by trade a ſilk dyer, and whoſe father at that time laboured under a third attack of madneſs, conſulted me about a glandular tumor upon the left ſide of his neck, of which he gave the following account: that for ſome time he had been troubled with an eruption which had gone off and returned repeatedly; that a week after its laſt diſappearance, he was ſeized with a fixed pain in his forehead, for which he was bled; that one day whilſt at work, after this pain had continued a fortnight, he felt a weakneſs in his left arm, and the bruſh with which he was working fell out of his hand, but he had no weakneſs in his right arm, nor in his legs. That this weakneſs returned two or three times a day for nine days; and was rather relieved by putting his hands into warm water. About three days after he was firſt attacked with this weakneſs, a tumor appeared on the left ſide of his neck, juſt below the ear, when I firſt ſaw him this tumor had continued eleven days. It ſeemed to be an enlarged lymphatic gland, was then hard, but afterwards gradually came to ſuppuration, and at the end of ſix weeks it burſt and diſcharged a yellow curdled matter. He adds at the ſame time that he was attacked with the weakneſs, he had a faultering in his ſpeech, and ſlight convulſions in his lips.

Now as in this caſe there ſeemed to be a compreſſion of the brain, which was removed when the glands ſwelled, is it not probable that the cauſe of the compreſſion had been ſome extravaſſed fluid, which afterwards being abſorbed, occaſioned the tumor and ſuppuration of the lymphatic gland? and therefore is it not a preſumption that abſorption is here likewiſe carried on by lymphatic veſſels?

The ſmall lymphatics which accompany the branches of the external carotid artery unite upon the neck, and form a large trunk which accompanies the internal jugular vein, paſſing through ſome lymphatic glands, near the termination of this trunk in the angle between the jugular and ſubclavian veins; there are likewiſe ſome glands on the outſide of this angle, which ſeem to belong to the lymphatics from the back of the neck, and of the ſhoulder.

The *Glandula Thyroidea* has many lymphatic veſſels, which can ſometimes be inflated by blowing air into the cells of the gland: theſe veſſels paſs on each ſide of the *trachea*, one part going into the angle of the right ſubclavian and jugular, and the other joining the thoracic duct upon the left ſide. They are ſeen in *Plate* IV. at *f*.

So much for the lymphatics of the head and neck, I ſhall next proceed to deſcribe thoſe which belong to the arms.

Each arm, like the leg, has two ſets of lymphatic veſſels, one which lies immediately under the integuments, and belongs to the ſkin and cellular membrane connecting it to the muſcles; and the other which accompanies the large arteries, and belongs to the parts deeper ſeated.

The ſuperficial ſet of lymphatic veſſels may be diſcovered in emaciated dropſical ſubjects, by a careful diſſection on the fore and back part of the arm, where I have fixed pipes into them and have injected them with mercury. In *Plate* V. they are ſeen running on the back part of the fore arm as at (a,a,a), moſt of them paſſing on its outſide, and twiſting to the fore part, near the head of the *radius*, as at (b). But there is one veſſel in this preparation which paſſes towards the inſide, under the inner condyle of the *os humeri* at (c), and ſends a branch amongſt the muſcles, which branch perforates the interoſſeous ligament, getting between the *radius* and *ulna* to the fore part, where it joins a deep ſeated one that had accompanied the radial artery.

In *Plate* VI. the lymphatic veſſels are ſeen on the fore part of the upper extremity; thoſe ſuperficial branches which paſſed on the outſide of the back of the fore arm appearing now on the fore part at (b) and aſcending under the ſkin that covers the *ſupinator longus* and the *biceps*, they enter ſome glands in the *axilla* at *(f, f)*, whilſt that veſſel which paſſed on the inſide of the back of the fore arm under the internal condyle, appears on the fore part at (c), and juſt above the condyle enters a gland *(d)*, and then paſſes up on the inſide of the arm, communicating with a lymphatic from the fore part of the wriſt, and paſſing to the axillary glands.

A ſuperficial lymphatic veſſel is ſeen under the ſkin, on the fore part of this extremity juſt above the wriſt, a pipe was introduced at (a), and the lymphatic thereby injected with mercury. This veſſel paſſes under the integuments over all the muſcles, and joins the lymphatic from the back part of the fore arm at *(e)*, and there forms a *plexus* which paſſes under the integuments, on the inſide of the arm to the axillary glands at *(f)*.

Beſides theſe ſuperficial lymphatic veſſels upon the upper extremity, I have traced a deeper ſeated one near the radial artery, and have injected it from a pipe fixed at *(g)*. This veſſel accompanies the radial artery, and paſſes, firſt under the interoſſeous, and then under the ulnar artery which in this ſubject runs over the muſcles. Near the part where it paſſes under the interoſſeous artery, it receives the branch (as formerly mentioned) from the back of the fore arm, After paſſing under theſe arteries, this lymphatic appears on the inſide of the bracheal artery at *(i)*, where it is deep ſeated, aſcending cloſe to that artery, and near the middle of the arm, paſſes through the two glands (k, k), after which it appears conſiderably enlarged, and goes under one of the *arteriæ anaſtomaticæ* at (l, m), and then aſcends to the lymphatic glands in the *axilla*.

But theſe veſſels, though filled more ſucceſsfully in this extremity than in any other that I ever injected, are only a part of the larger lymphatic veſſels of the arm, as there are probably ſome accompanying the ulnar and interoſſeous arteries, although not here injected: and they ſhould moreover be conſidered as only trunks of the lymphatics, ſince it is probable, that every (even the ſmalleſt) part of this, as well as all other parts of the body, has one of theſe veſſels adapted to abſorption: that this is the caſe ſeems to be proved by the experiments made with the variolous matter, for at what part ſoever of the arm that matter is inſerted, the lymphatic veſſels take it up and carry it into the body, as can be traced by its inflaming the conglobate glands through which theſe veſſels paſs.

In *Plate* IV. the termination of all theſe lymphatic veſſels is exhibited.

Two of the trunks of thoſe of the left arm are ſeen at *d*, *d*, which paſs under the clavicle, whoſe cut end is ſeen at *D*, and under the ſubclavian vein *S*, where, having joined, they form the large trunk *(e)*, which appears juſt above the left ſubclavian vein, and joins the extremity of the thoracic duct at its entrance into the angle between that vein and the jugular. That theſe lymphatics commonly join the thoracic duct, as is here deſcribed, I am perſuaded from having ſeen it diſtinctly in three ſubjects. But that they may, in ſome inſtances, open into the ſubclavian vein before they reach the angle, I think is likewiſe probable from having obſerved it in the caſe above mentioned, in which caſe, the thoracic duct having ſplit into two trunks, one of theſe trunks, inſtead of entering the angle between the veins, opened into the ſubclavian itſelf, about an inch from the angle; but this circumſtance I ſhould conſider as only an exception from a general rule.

The thoracic duct is not only joined by this trunk of the lymphatics of the left arm, but alſo by the lymphatic veſſels of the left ſide of the thyroide gland, which appear at *(f)*, and by the trunk of the lymphatics of the left ſide of the head and neck, and alſo by thoſe from the fore part of the lungs of the ſame ſide; but neither of theſe appear in this plate.

The lymphatic veſſels of the right ſide I have repeatedly traced with great care, particularly from their having been ſuſpected to terminate in the ſubclavian vein, without reaching the angle between it and the jugular; but I have always diſtinctly ſeen them go preciſely into the angle, not only in the ſubject from which this plate was made, and which I now have by me, but alſo in three others. When therefore theſe lymphatics are ſeen to enter the ſubclavian vein at any other part, I ſhould conſider it as only an accidental variety, like the double termination of the thoracic duct formerly mentioned.

Theſe lymphatic veſſels of the right ſide form four conſiderable trunks, which join near their termination. Theſe trunks are, firſt one from the upper extremity, which appears at *(k)*, *Plate* IV. lying above the clavicle between the ſubclavian artery and vein: This trunk is formed by the lymphatic *g*, *g*, which comes up with the brachial artery, and the *plexus (h)*, which likewiſe belongs to the arm, and paſſes under the ſubclavian vein. Secondly, the trunk of the lymphatic veſſels of the right ſide of the head and neck which paſſes down on the outſide of the jugular vein, as is ſeen at *(l)*. Thirdly, a lymphatic from the thyroide gland, which lymphatic is ſeen at *(m)*, paſſing under the right jugular vein to get to the others. Fourthly, the trunk of the lymphatics from the fore part of the lungs of the right ſide, which trunk I have diſtinctly traced under the ſubclavian vein to its termination, in common with the others, at the angle between the jugular vein and the ſubclavian.

To finiſh this deſcription, I ſhall obſerve that it is the more neceſſary to underſtand the exact termination of theſe lymphatics of the right ſide, in order to explain how tumors about this place, by compreſſing thoſe veſſels, occaſion œdematous ſwellings of the parts from which the veſſels come, without affecting the other parts of the body.

CHAP. IV.

A Deſcription of the Lymphatic Syſtem in Birds[*].

THIS Syſtem conſiſts in birds, as it does in the human ſubject, of three parts, *viz.* the lacteals, the lymphatic veſſels, and their common trunk the thoracic duct.

The lacteals indeed, in the ſtricteſt ſenſe, are, in birds, the lymphatics of the inteſtines, and like the other lymphatics carry only a tranſparent lymph. And inſtead of one thoracic duct there are two which go to the two jugular veins. In theſe circumſtances, it would ſeem, that birds differ from the human ſubject, ſo far at leaſt as I may judge from the diſſection of a gooſe, which was the bird I choſe as moſt proper for this inquiry, and from which I took the following deſcription, after previouſly injecting its lymphatic ſyſtem with quick-ſilver.

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[*] This deſcription has already been printed in the Philoſophical Tranſactions, Vol. LVIII. where I have added a plate, which was thought unneceſſary in this book.

The lacteals run from the inteſtines upon the meſenteric veſſels. Thoſe of the *duodenum* paſs by the ſide of the *pancreas*, and probably receive its lymphatics: afterwards they get upon the cœliac artery, of which the ſuperior meſenteric is a branch. Whilſt they are upon this artery they are joined by the lymphatics from the liver; here they form a *plexus*, which ſurrounds the cœliac artery; at this part they receive a lymphatic from the gizzard; and a little farther, another from the lower or glandular part of the *œſophagus.* Having now got to the root of the cœliac artery, they are joined by the lymphatics from the *glandulæ renales,* or renal *capſulæ;* and near the ſame part, by the lacteals from the other ſmall inteſtines, which veſſels accompany the lower meſenteric artery. Theſe laſt mentioned lacteals, before they join thoſe from the *duodenum,* receive from the *rectum* a lymphatic which runs with the blood-veſſels of that gut. Into this lymphatic ſome ſmall branches from the kidneys ſeem to enter, which coming from thoſe glands upon the meſentery of the *rectum,* at laſt open into its lymphatics. At the root of the cœliac artery, the lymphatics of the lower extremities probably join thoſe from the inteſtines. The former I have not yet traced to their termination, though I have diſtinctly ſeen them on the blood-veſſels of the thigh; and in one ſubject, which I injected, ſome veſſels were filled, contrary to the courſe of the lymph, from the network near the root of the cœliac artery; theſe veſſels ran behind the *cava*, down upon the *aorta*, near to the origin of the crural arteries, and I preſume they were the trunks of thoſe branches which I had ſeen in the thigh. At the root of the cœliac artery, and upon the contiguous part of the *aorta*, a network is formed by the lacteals and lymphatics above deſcribed. This network conſiſts of three or four tranſverſe branches, which make a communication between thoſe which are lateral. In the ſubject from which this deſcription was taken, there were four. From this network ariſe the two thoracic ducts; of which one lies on each ſide of the ſpine, and runs upon the lungs obliquely up towards the jugular vein, into which it opens, not indeed into the angle between the jugular and ſubclavian vein, as in the human ſubject, but into the inſide of the jugular vein, nearly oppoſite to the angle. The thoracic duct of the left ſide is joined by a large lymphatic, which runs upon the *æſophagus*, and can be traced as far as the lower or glandular part of that canal; from which part, or from the gizzard, it ſeems to iſſue. The thoracic ducts are joined by the lymphatics of the neck (and probably by thoſe of the wings) juſt where they open into the jugular veins.

The lymphatics of the neck generally conſiſt of two pretty large branches, on each ſide of the neck, accompanying the blood-veſſels*. Thoſe two branches join near the lower part of the neck; and the trunk is, in general, as ſmall, if not ſmaller, than either of the branches. This trunk runs cloſe to the jugular vein, gets on its inſide, and then opens into a lymphatic gland. From the oppoſite ſide of this gland, a lymphatic comes out, which pours the lymph into the jugular vein. On the left ſide, the whole of this lymphatic joins the thoracic duct of the ſame ſide, but, on the right, one part of it goes into the inſide of the jugular vein a little above the angle, whilſt another joins the thoracic duct, and, with that duct, forms a common trunk which opens into the inſide of the jugular vein, a little below the angle which that vein makes with the ſubclavian.

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* Theſe lymphatics in the necks of fowls were firſt diſcovered by Mr. John Hunter.

This ſyſtem in birds differs moſt from that in quadrupeds, in the chyle being tranſparent and colourleſs; and in there being no viſible lymphatic glands, neither in the courſe of the lacteals, nor in that of the lymphatics of the *abdomen,* nor near the thoracic ducts.

For the ſake of thoſe who may incline to proſecute this inquiry farther, I ſhall relate the method by which theſe veſſels may be demonſtrated; and that is, having choſen a young and very lean gooſe, and fixed it upon a table, let the *abdomen* be opened whilſt it is yet alive, and a ligature be paſſed round its meſenteric veſſels, as near the root of the meſentry as poſſible. The lacteals will begin to appear near the ligature in a few minutes after it is made, eſpecially if the bird has been well fed three or four hours before the experiment. The lymphatics in the neck may be ſhewn in the ſame manner; that is, by making a ligature on the jugular vein at the lower part of the neck; and to be more certain of including the lymphatics which are near it, we muſt take care not to paſs the needle too cloſe to that vein.

CHAP. V.

A Deſcription of the Lymphatic Syſtem in one of the Animals called amphibious, viz. the Turtle.

THIS ſyſtem in a turtle, like that in birds, conſiſts of the lacteals, the lymphatics, and their common trunks, the thoracic ducts. It agrees likewiſe with that in birds, in not having any lymphatic glands either on the meſentery or near the thoracic ducts; but differs from that in birds, in not having any glands upon the larger lymphatics of the neck; at leaſt I am inclined to believe ſo, from not having ſeen any in the diſſection of one animal of this ſpecies in which I looked for them. It likewiſe differs from that in birds in another circumſtance, to be taken notice of hereafter. Whether it agrees with the ſame ſyſtem in birds, in the tranſparency and want of colour in the chyle, I cannot take upon me to determine, as I did not ſee any of that fluid in this ſubject (*a*).

The following deſcription I took from the animal, after I had injected the larger branches of this ſyſtem with a coloured wax, and the ſmaller with quickſilver. To avoid my being miſunderſtood, when I ſpeak of the ſituation of the different parts, I ſhall mention, once for all, that the deſcription was taken from the ſubject as it lay upon its back; thoſe parts being called higheſt which were neareſt the

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(*a*) In a crocodile, an animal of the ſame claſs, the chyle is white.

head, thoſe loweſt which were neareſt the tail, thoſe poſterior which were neareſt the back, and thoſe anterior neareſt the belly (*b*).

The lacteals accompany the blood-veſſels upon the meſentery, running by their ſides, and communicate frequently acroſs thoſe veſſels. Near the root of the meſentery they anaſtomoſe, ſo as to form a net-work, from which ſeveral large branches go into ſome conſiderable lymphatics lying on the left ſide of the ſpine. Theſe laſt can be traced downwards almoſt to the *anus*, and belong to the parts ſituated below the meſentery, and particularly to the kidneys. At the root of the

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(*b*) The animal, from which I took this deſcription, was pretty large, meaſuring from the lower to the upper part of the ſhell two feet ſeven inches, and two feet two inches from ſide to ſide.

meſentery, on the left ſide of the ſpine, the lymphatics of the ſpleen join the lacteals, and immediately above this union a ſort of *plexus*, or net-work, is formed, which lies upon the right *aorta* (for there are two *aortæ* in this animal). From this *plexus* a large branch ariſes, which paſſes behind the right *aorta* to the left ſide, and gets before the left *aorta*, where it aſſiſts in forming a very large *receptaculum* which lies upon that artery. From this *receptaculum* ariſe the thoracic ducts. From its right ſide goes one trunk, which is joined by that large branch which came from the *plexus* to the left ſide of the right *aorta*, and then paſſes over the ſpine. This trunk is the thoracic duct of the right ſide; for, having got to the right ſide of the ſpine, it runs upwards, on the inſide of the right *aorta*, towards the right ſubclavian vein. And when it has advanced a little above the lungs, or within three or four inches of the ſubclavian vein, it divides into branches, which, near the ſame place, are joined by a large branch that comes up on the outſide of the *aorta.* From this part upwards thoſe veſſels divide and ſub-divide, and are afterwards joined by the lymphatics of the neck, which likewiſe form branches before they join thoſe from below; ſo that between the thoracic duct and the lymphatics of the ſame ſide of the neck a very intricate net-work is made. From this net-work a branch goes into the angle between the jugular vein and the lower part or trunk of the ſubclavian: this branch, therefore, lies on the inſide of the jugular, whilſt another gets to the outſide of that vein, and ſeems to open into it a little above the angle between that vein and the ſubclavian. I ſay ſeems to open, for the injection had not ſucceeded at this part ſo as to enable me to determine whether the laſt-mentioned branch did enter or not. Into the above-mentioned *receptaculum*, the lymphatics of the ſtomach and *duodenum* likewiſe enter. Thoſe of the *duodenum* run by the ſide of the *pancreas*, and probably receive its lymphatics, and a part of thoſe of the liver. The lymphatics of the ſtomach and *duodenum* have very numerous *anaſtomoſes*, and form a beautiful net-work on the artery which they accompany. From this *receptaculum* likewiſe (beſides the trunk already mentioned which goes to the right ſide) ariſe two other trunks pretty equal in ſize; one of which runs upon the left ſide, and the other upon the right ſide of the left *aorta*, till they come within two or three inches of the left ſubclavian vein; where they join behind the *aorta*, and form a number of branches which are afterwards joined by the lymphatics of the left ſide of the neck: ſo that here a net-work, or *plexus*, is formed, as upon the right ſide. From this *plexus* a branch iſſues, which opens into the angle between the jugular and the lower part or trunk of the ſubclavian vein. In theſe net-works, formed by the lymphatics near their terminations in the veins, this ſyſtem in the turtle likewiſe differs remarkably from that in birds.

So much for the general deſcription of the lymphatic ſyſtem in this animal, I ſhall next add what I have remarked as to the more minute diſtribution of its lacteals. In the firſt place, it may be obſerved, that what knowledge we have of the minute diſtribution of thoſe veſſels in quadrupeds has been acquired from examining them when filled with their natural fluid, the chyle; for the valves with which thoſe veſſels abound prevent our injecting their ſmaller branches, as we do thoſe of the arteries and veins of the inteſtines. But in this animal, I have been ſo fortunate as to force the valves, and to inject the lacteals from their trunks to their branches, ſo as to fill them all around with quickſilver, in ſeveral parts of the inteſtine. In theſe experiments I obſerved, that the quickſilver was often ſtopped by the valves, where the lacteals run upon the meſentery, or where they are juſt leaving the inteſtine; but when thoſe valves were forced, and the quickſilver had once got upon the ſurface of the gut, it generally ran forward without ſeeming to meet with any obſtacle. The lacteals anaſtomoſe upon the inteſtines, ſo that the quickſilver, which has got upon them by one veſſel, in general, returns by another, at ſome diſtance. The larger lacteals, which run upon the inteſtines, accompany the blood-veſſels; but the ſmaller lacteals neither accompany thoſe veſſels, nor paſs in the ſame direction, but run longitudinally upon the gut, and dip down through the muſcular coat into the cellular or nervous, as it has been called, which in this animal is very thin in compariſon to what it is in the human ſubject. So far I have traced thoſe veſſels to my ſatisfaction; but what becomes of them after they have got to the cellular coat is not ſo eaſy to determine: in five or ſix different experiments which I have made, the mercury paſſed from the lacteals into the cells between the muſcular coat and the internal, and ſpread from cell to cell, very uniformly, over a great part of the inteſtine, although but little force had been uſed, and although there was nothing like extravaſation in any other part of the inteſtine. Upon inverting the inteſtine, after thus filling its lacteals, the mercury, on being preſſed, was, in many parts, driven into ſmall veſſels upon the internal coat, or villous, as it is called. From whence it would ſeem, that this cellular net-work was a part of the lymphatic ſyſtem in this animal. It might indeed be ſuppoſed to be mere extravaſation; but that it is rather a part of the lymphatic ſyſtem appears probable from the following conſiderations. Firſt, from the regularity in the ſize of the cells. Secondly, from the little force uſed in the experiment, and from there being nothing like this appearance in the cellular membrane between the peritoneal and the muſcular coat, where extravaſations were as likely to happen. Thirdly, from my having been able, after inverting the inteſtine, to preſs the quickſilver from the cells into the very ſmall veſſels upon the internal coat; but I muſt confeſs theſe facts would not be ſufficient to determine whether theſe cells were, or were not a part of the ſyſtem, did not the analogy of the ſame part in fiſh clearly prove it. For in the cod, inſtead of the cellular net-work, as in the turtle, there is a net work of veſſels (of which a deſcription ſhall be given in the next chapter) ſo that I have now no doubt but that thoſe cells are parts of the lymphatic ſyſtem, and that the ſmall abſorbent veſſels of the internal coat pour their fluid into this net-work, from which it is conveyed by the larger lacteals.

CHAP. VI.

The Method of diſcovering the Lymphatics in Turtle and in Fiſh, together with a Deſcription of thoſe Veſſels in a Haddock.

IN the foregoing chapter on the lymphatic ſyſtem in a turtle, I have made no mention of the manner of diſcovering thoſe veſſels, becauſe there is no difficulty in doing it; for in that animal the meſentery being very thin and tranſparent, and the lacteals pretty large, they are more readily obſerved than in any other animal; thence it happened that I ſaw thoſe veſſels in a turtle ſo long ago as 1763, which was before I diſcovered them in birds and fiſh.

But although it was an eaſy matter to ſee thoſe veſſels in the turtle, yet it was far from being ſo in birds and fiſh; as the reader will readily believe, from their having been ſo often ſought for in vain by ſo many eminent anatomiſts, particularly of this age. I may add, that the diſcovery in birds did not give me ſo much trouble as that in fiſh, though now, ſince I have once ſeen them, I can more readily find them in fiſh than in birds or quadrupeds. After ſeeing them in birds, and in one of the *amphibia*, I was very deſirous of determining whether fiſh were, or were not provided with thoſe veſſels. This I endeavoured to do in the ſame way that I had found them in birds, that is, by tying up the meſenteries of live fiſh; and for this purpoſe I went frequently to the markets, and examined ſeveral ſmall ones. I likewiſe diſſected ſome larger, when dead, but in vain. I next went to Brighthelmſtone, where I found kingſton, or monk-fiſh, a ſpecies of ſkate. Theſe being very large, and having a lean meſentery, ſeemed well fitted to my purpoſe. I opened two of them alive, tied up their meſenteric veſſels, and put them again into the ſalt water; and though one of them lived an hour, I could not obſerve any lacteals either upon its inteſtine or its meſentery. After this, I repeatedly examined the inteſtines and meſenteries of common ſkate and cod, and at laſt was ſo fortunate as to diſcover the lacteals, and get a pipe into one of thoſe veſſels on the meſentery of each of theſe fiſh; and, injecting by this pipe, I found where the larger veſſels lay; after which there was but little difficulty in tracing the whole ſyſtem. I have now ſeen thoſe veſſels in a variety of fiſh, and ſhall give a deſcription of them from a haddock. I ſhall proceed exactly in the order which I have found moſt convenient for tracing out the whole ſyſtem for demonſtration, beginning with one of its branches, which, as lying neareſt the ſurface, muſt, of courſe, be divided before the other parts can be expoſed to view. The account being taken from the fiſh as it lay on its back, thoſe parts are called ſuperior which are neareſt the head; thoſe inferior which are towards the tail; thoſe poſterior which are towards the back, and thoſe anterior which are towards the belly.

On the belly of the fiſh, exactly in the middle line, is a lymphatic, which runs from the *anus* upwards; this lymphatic belongs not only to the *parietes* of the belly, but to the fin below the *anus*. It runs up towards the head, paſſes between the two pectoral fins, and, having got above them, it receives their lymphatics. It then goes under the *ſymphyſis* of the two bones which form the *thorax*, where it opens into a net-work of very large lymphatics, which lies cloſe to the *pericardium*, and almoſt intirely ſurrounds the heart. This net-work, beſides that part of it behind the heart, has a large lymphatic on each ſide, which runs upon the bone of the *thorax* backwards, and when it has got as far as the middle of that bone, it ſends off a large branch from its inſide to join the thoracic duct. After detaching this branch, it is joined by the lymphatics of the thoracic fins, and, ſoon after, by a lymphatic which runs upon the ſide of the fiſh. This laſt-mentioned veſſel conſiſts of a trunk running on the ſide juſt oppoſite to the ribs, and from this trunk proceed branches on each ſide immediately under the ſkin; ſo that it has a beautiful penniform appearance. Beſides theſe branches, there is another ſet, deeper ſeated, which accompanies the ribs. After the large lymphatic has been joined by the above-mentioned veſſels, it receives the lymphatics from the poſterior extremities of the gills, and having now got as far back as the orbit, it next receives lymphatic veſſels from that cavity; but theſe veſſels do not belong merely to the orbit; for one of them comes from the noſe, and another from the upper part of the mouth. A little below the orbit another net-work appears, conſiſting, in part, of the veſſels above deſcribed, and of the thoracic duct. This net-work is very complex; ſome of its veſſels lie on each ſide of the muſcles belonging to the gills, and from its internal part a veſſel goes into the jugular vein, by which veſſel the whole ſyſtem is terminated. The large lymphatic

phatic above mentioned, which lies upon the bone of the *thorax*, has likewiſe a proceſs running towards the upper part of the kidney, and receives ſome of the lymphatics of that organ.

The lacteals run on each ſide of the meſenteric arteries, anaſtomoſing frequently acroſs thoſe veſſels. The *receptaculum*, into which they enter, is very large in proportion to them, and conſiſts, at its lower part, of two branches, of which one lies between the *duodenum* and ſtomach, and runs a little way upon the *pancreas*, receiving the lymphatics of the liver, *pancreas*, thoſe of the lower part of the ſtomach, and the lacteals from the greateſt part of the ſmall inteſtines. The other branch of the *receptaculum* receives the lymphatics from the *rectum*, and the lacteals from the greateſt part of the ſmall inteſtines. The *receptaculum*, formed by theſe two branches, lies on the right ſide of the upper part of the ſtomach, (or the lower part of the *æſophagus*) and is joined by ſome lymphatics from that part; and alſo by ſome ſmall veſſels from the ſound, and from the gall bladder, which, in this fiſh, adheres to the *receptaculum*. The thoracic duct takes its riſe from the *receptaculum*, and lies on the right ſide of the *æſophagus*, receiving lymphatics from that part; and running up a little way (viz. about half an inch in this fiſh) it divides into two branches or ducts, one of which paſſes under the *æſophagus* to the left ſide, and the other goes ſtraight up, on the right ſide, paſſes by the upper part of the kidney, from which it receives ſome ſmall branches, and, ſoon after, is joined by a branch from the large lymphatic that lies above the bone of the *thorax*, as formerly mentioned.

It likewiſe, near this part, ſends a branch to join the duct of the oppoſite ſide, and then, a little higher, is joined by thoſe large lymphatics which make a net-work behind the heart, as is above deſcribed. Theſe laſt mentioned veſſels receive the lymphatics from the anterior, or ſuperior part of the gills, and from the *fauces*. The thoracic duct, after being joined by theſe veſſels, communicates with that net-work near the orbit; where its lymph is mixed with that of the lymphatics from the poſterior part of the gills, from the ſuperior fins, belly, &c. and then from this net-work a veſſel goes into the jugular vein, juſt below the orbit. This laſt veſſel, which I call the termination of the whole ſyſtem, is very ſmall in proportion to the net-work from which it riſes; and indeed the lymphatics, at this part, are ſo large as to exceed, by far, the ſize of the ſanguiferous veſſels.

The thoracic duct of the left ſide, having paſſed under the *æſophagus* from the right, runs on the inſide of the *vena cava* of the left ſide, receives a branch from its fellow of the oppoſite ſide, and joins the large lymphatics which lie on the left of the *pericardium*, and a part of thoſe which lie behind the heart, and afterwards makes, together with the lymphatics from the gills, upper fins, and ſide of the fiſh, a net-work, from which a veſſel paſſes into the jugular vein of this ſide. In a word, the lymphatics of the left ſide agree exactly with thoſe of the right, as above deſcribed.

Beſides theſe veſſels, there is yet another part of the ſyſtem which is deeper ſeated, lying between the roots of the ſpinal proceſſes of the back-bone: this part conſiſts of a large trunk, that begins from the lower part of the fiſh near the tail, and, as it aſcends, receives branches from the dorſal fins, and from the adjacent parts of the body. It goes up near to the head, and ſends a branch to each thoracic duct, near the part where theſe ducts come off from their common trunk.

This deſcription, though taken from a haddock, agrees, I believe, pretty exactly with the diſtribution of thoſe veſſels in the cod, whiting, and perhaps all other fiſh of the ſame ſhape.

To this general deſcription I ſhall add, what I have obſerved of the more ſtriking peculiarities of this ſyſtem in fiſh.

In the firſt place, thoſe veſſels are remarkable in not having any lymphatic

phatic glands, that I can diſcover, in any part of their courſe. In this they agree with the turtle, but differ from birds, which have lymphatic glands on the veſſels of their necks.

Secondly, theſe veſſels in fiſh either have no valves, or the valves readily give way, for it is an eaſy matter to fill them contrary to the courſe of the lymph. When I firſt obſerved this circumſtance, I imagined, that by injecting minutely thoſe veſſels, I might diſcover their very beginnings, and that I might alſo be enabled to determine, whether ſuch parts as the brain, eye, &c. of which the lymphatics have not been yet ſeen in any animal, have, or have not ſuch veſſels. What ſucceſs I have had in theſe experiments will be related in a future publication.

Thirdly, the lacteals in the cod (and I preſume in moſt other fiſh) are remarkable for having a beautiful net-work of veſſels between the muſcular and villous coat of the inteſtines (*c*). This net-work may be filled from the lacteals on the meſentery with the leaſt force imaginable. If mercury be injected into this net-work at one part, it ſpreads over the inteſtine; the communications in the net-work being very numerous: if the inteſtine be inverted, and the mercury ſqueezed, it is eaſily driven into the ſmall veſſels of the *villi* of the internal coat*. From theſe veſſels the mercury can be forced into the cavity of the inteſtine; but not ſo eaſily as to make it clear, whe-

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(*c*) I have ſeen this net-work in the turbot, plaice, and cod.

* If inſtead of mercury a thin ſize be uſed, as an injection, it will run with the ſame facility into the lacteals upon the villi, as it would do into their arteries and veins, when thrown in by a pipe fixed in thoſe veſſels.

ther they have, or have not a valve at their beginning. In theſe circumſtances there is a ſtrong analogy between fiſh and the turtle; but in fiſh it is more evident that there can be no deception as to the net-work between the muſcular and the internal coat; for in them it is made up of cylindrical veſſels, and is not cellular as in the turtle, and therefore not in the leaſt like an extravaſation: and in fiſh the veſſels on the internal coat are larger than in the turtle.

Fourthly, this ſyſtem agrees with that of the turtle, in having a very large *receptaculum*, and in having the net-work of large veſſels near its termination in the ſanguiferous ſyſtem; and likewiſe in having the veſſel, which goes from the net-work into the vein, ſmall in proportion to the ſize of that net-work: ſo that the lymph muſt be lodged ſome time in thoſe parts before it is poured into the maſs of blood. In birds I alſo obſerved ſomething like this, their lymphatic ſyſtem being enlarged, or varicoſe at different parts; but theſe enlargements are ſmall in proportion to thoſe abovementioned in fiſh and turtle.

As to the manner of diſcovering thoſe veſſels in a fiſh, one might naturally ſuppoſe, that when it is known where the *receptaculum*, or any of the larger parts of this ſyſtem lie, it could not be difficult to find them; but the coats of theſe veſſels are ſo thin and tranſparent, that it is by no means eaſy. The readieſt way of finding the whole ſyſtem is, to look for one of the veſſels which lie cloſe to the ſkin; as, for inſtance, that which runs up exactly on the middle of the belly of the haddock, cod, and other fiſh of the ſame ſhape. This veſſel is eaſily ſeen as it grows pretty large at its upper part, near the head; and if a pipe be introduced, the whole ſyſtem may be filled by its means.

It is partly owing to the eaſe with which thoſe veſſels may be ſeen, after diſcovering where their larger branches lie, that I have not added a figure of this ſyſtem in a fiſh. Indeed it would be almoſt impoſſible to expreſs all its parts in one figure, from the numerous and intricate communications of thoſe veſſels near their termination in the common veins. But I formerly laid before the Royal Society a haddock with its lymphatics and blood-veſſels filled with coloured injections, to be compared with the deſcription which was printed in the Philoſophical Tranſactions, Vol. 59. And thoſe that are deſirous of proſecuting this ſubject further, will, I flatter myſelf, find it an eaſy matter to fill the whole ſyſtem by attending to what I have ſaid above.

CHAP. VII.

On the Properties of the Lymph contained in the Lymphatic Veſſels, and of that which lubricates the different cavities of the Body.

AS the fluid contained in the lymphatic veſſels reſembles water in the circumſtances of tranſparency and want of colour, thence their firſt diſcoverers denominated theſe veſſels *ductus aquoſi*, and ſeem to have concluded that the lymph was nothing but water.

This opinion ſome of the ſucceeding phyſiologiſts, particularly the learned *Boerhaave*, rendered more probable, by ſuppoſing that there were three ſeries of arteries; the ſanguiferous, the ſeriferous, and the lymphatic; and that thoſe lymphatic veſſels we are now deſcribing were only veins correſponding to the lymphatic arteries, to reſtore their lymph to the heart. Thence the lymph ſeems to have been concluded the thinneſt part of our fluids; in which opinion phyſiologiſts were confirmed by *Leeuwenhoeck's* theory, that the globules of lymph were ſmaller than thoſe of the ſerum, or of the red part of the blood.

The fluids that moiſten the different cavities of the body, *viz.* that of the *peritoneum*, *pleura*, *pericardium*, &c. being ſuſpected to be formed ſolely from the condenſation of that ſteam which appears on opening an animal juſt killed, have thence been alſo conſidered as mere water by ſome anatomiſts and phyſiologiſts, who were confirmed in this opinion by obſerving, that in dropſies, where a great quantity of fluid is let out from ſuch cavities, it is commonly a mere water, ſeldom coagulating either when expoſed to the air or to heat*.

But notwithſtanding the plauſibility of all the arguments from which ſuch concluſions were made, with reſpect to theſe fluids, it will appear in the ſequel, that although they be ſo tranſparent in living animals, and ſo watery in dropſies, yet in animals in health they differ ſo much from water, that they not only coagulate when expoſed to heat, but alſo when merely expoſed to the air; in which circumſtance they agree moſt with that part of the blood called the coagulable lymph, as is evident from the following experiments*.

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* Agreeably to this opinion, theſe dropſies are ſaid to be occaſioned by an *increaſed ſecretion*, or an *impeded abſorption*, which ſuppoſes that the fluids, naturally moiſtening theſe cavities, are the ſame as thoſe let out from them in dropſical caſes.

EXPERIMENT I.

If ſoon after killing an animal in health, the *abdomen*, *thorax*, or *pericardium* be opened; and if a little of the fluid that moiſtens theſe cavities be collected, which (even in caſes where the quantity is very ſmall) may be done by gently ſcraping the ſurface of theſe cavities with a wet tea-ſpoon, and if the fluid thus collected be ſuffered to reſt, expoſed to the air, it will jelly as the coagulable lymph of the blood does. This is an experiment which I have made on a conſiderable number of animals, viz. on bullocks, dogs, geeſe and rabbits, and the reſult of all the experiments was the ſame.

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* From amongſt thoſe who concluded theſe fluids a mere water ſhould be excepted M. de Haller, —See his El. Phyſ.—And Profeſſor Monro ſays, they coagulate by cold and reſt. Ob. An. and Ph. p. 68.

EXPERIMENT II.

If immediately after killing an animal in health, a lymphatic veſſel be tied up properly, and then cut out of the body and opened, ſo as to let out the lymph into a cup and expoſe it to the air, it will jelly as the coagulable lymph of the blood does in the ſame circumſtances; this experiment I have likewiſe made ſeveral times on dogs, aſſes and geeſe.

With reſpect to that fluid which moiſtens the cellular ſubſtance, or cellular membrane, as it is called, I cannot ſpeak with ſo much preciſion, ſince it cannot be collected in animals in health; but when we conſider how great a probability there is of the lymphatic

phatic veſſels abſorbing that fluid, we may ſuſpect that it is ſimilar to what moiſtens the *pericardium*, *thorax*, *abdomen*, &c. eſpecially as I have repeatedly obſerved, that the lymph returning from the extremities by their lymphatic veſſels, coagulates when expoſed to the air equally as the lymph nearer the center of the body.

Since then, thoſe fluids in healthy animals coagulate ſpontaneouſly on being expoſed to the air, may we not conclude that they reſemble the coagulable lymph of the blood at leaſt more than they do the water, or even than they do the *ſerum*, which does not jelly on being expoſed to the air? And is it not an argument in favour of this inference, that ſuch a fluid appears fitter for the office of lubrication than mere water, and more ſimilar to the *ſynovia*, which of all fluids is the beſt adapted to that purpoſe?

But although from theſe experiments I am convinced that the lymph in theſe cavities and veſſels of an healthy animal will always jelly on being expoſed to the air, yet I have likewiſe obſerved that the ſtrength of that jelly is different in different animals. In geeſe theſe fluids jelly ſooner than in dogs; and in the ſame animals the jelly differs in the different circumſtances of health: in moſt of the dogs which I examined the contents of the lymphatics formed a ſtrong jelly, but in a dog which I had fed eight days with bread and water, and that rather ſparingly, the lymph formed a very weak jelly; and in young geeſe, theſe fluids are later in jellying than in ſuch as are full grown. I have obſerved the ſame of the fluid contained in the *pericardium* and *abdomen* of other animals, which fluid, when in a ſmall quantity, always formed a ſtrong jelly, but when more copious, and the animal more feeble, the jelly was thinner; and in dropſical caſes, it is well known that the fluid let out of theſe cavities is not obſerved to jelly on being expoſed to the air, as it does in animals in health; but in ſome caſes it is found to coagulate by heat, like the ſerum of the blood, and in others it only becomes a little turbid when boiled, owing to the coagulable matter being in very ſmall proportion to the water.

Although this lymph becomes more watery in a weak ſtate of the animal, it is leſs watery and more coagulable in ſome diſeaſes.

But, what is a more curious fact, in thoſe caſes where I have compared the fluid contained in the *abdomen* and *pericardium*, with that contained in their lymphatic veſſels, of animals in different ſtates of health; I have always found them agree with one another in the degree of coherence of the jelly which they formed. For, when the animal was in perfect health, the lymph from the cavity of the *pericardium*, *abdomen* and *pleura* formed a ſtrong jelly, and that in the lymphatics of the neck and extremities was equally firm: When the animal was reduced, as in the dog fed eight days on bread and water, or when the gooſe was very young, then the jelly, formed by the fluid collected in theſe cavities, was weak, and that formed by the lymph in the lymphatic veſſels was likewiſe weak in the ſame proportion. So that although theſe fluids vary in the different circumſtances of health, yet they always agree with each other.

Theſe fluids, likewiſe, as we have before obſerved, beſides agreeing with one another, approach to the nature of the coagulable lymph of the blood in the circumſtance of coagulating when expoſed to the air, but they differ from it in the time neceſſary for that coagulation. In dogs that were ſeemingly in perfect health, whoſe blood, and whoſe lymph were let out of their veſſels at the ſame time, the lymph was found to be much later in coagulating than the blood. The time which the blood requires for its coagulation is about ſeven minutes after expoſition to the air, but the lymph let out from the lymphatic veſſels of the ſame animals, was found to require half an hour, or more, for its coagulation. And although the blood coagulates ſooneſt in the weak animals, yet the contents of the lymphatic veſſels, or the fluids in theſe cavities do not, but ſeem later in jellying in proportion as the animal is reduced, or as they become more watery.

Moreover, the coagulable lymph of the blood and the lymph of the lymphatic veſſels, not only differ from one another in the time which they require for their coagulation when expoſed to the air, but alſo they differ more evidently in the time required for their coagulation in the body when merely at reſt without being expoſed to air. As, for inſtance, in a dog killed whilſt in health, and whoſe veins and lymphatic veſſels were tied up immediately after his death, the blood in the veins was completely jellied in ſix hours, but the lymph in the lymphatic veſſels of his neck was perfectly fluid twenty hours after his death, and, being let out at this time, jellied after being for ſome time expoſed to the air.

There is another change of the lymph very evident beſides thoſe already mentioned, for, it not only is varied from the natural ſtate to the more watery, but alſo from the natural to the more viſcid or coagulable; inſtances of which occur in thoſe inflammatory cruſts that are found, in ſome diſeaſes, to cover the different parts of the body. Thus, the outſide of the heart, and the inſide of the *pericardium* are ſometimes covered with a cruſt as tough as the ſize in pleuritic blood, and the ſurface underneath has marks of inflammation, but is not ulcerated. Probably, therefore, it is the inflammation which produces that change, or which makes the exhalant arteries ſecrete a lymph with ſuch an encreaſed diſpoſition to coagulate. Add to this, that the change which inflammation thus ſeems to produce is juſt the oppoſite to that produced by the dropſy, for in the dropſy the fluid is ſecreted with an extraordinary quantity of water and too little coagulable matter; but in inflammations the fluid is ſecreted with a greater proportion of coagulable matter, and with leſs water; and in ſome inſtances it ſeems to be a pure coagulable lymph, either unchanged by the exhalants, and then coagulating gradually on being at reſt, as the coagulable lymph is found to do in the veins that are tied*; or elſe the exhalant veſſels have the power of changing its properties, ſo as to make it coagulate in an inſtant after being ſecreted. And this ſuppoſition of the exhalants having a power of changing the properties of the lymph, is rendered probable from the following conſideration, *viz.* that it is ſometimes found coagulated in the inner ſurface of the heart, forming a cruſt, ſimilar to what we ſo often ſee on the outſide. Now as there is a conſtant current of blood through the heart, unleſs the lymph forming that cruſt had coagulated inſtantly on being ſecreted, it muſt have been waſhed off by the blood. One of the cleareſt inſtances of this was obſerved by Sir John Pringle, who has given me leave to tranſcribe from his notes the following circumſtances of the caſe.

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* See Exp. Inquiries, Part 1ſt. Pag. 23.

"Mr. J——, who had for ſome time been ſubject to palpitations of the heart, and who (perhaps from another cauſe) happened to die apoplectic, was carefully opened after death, and two ounces of water were found in the ventricles of the brain.—

"The heart was large, and adhered in ſome places to the *pericardium* in ſuch a manner as parts adhere from recent inflammation, that is by an exudation of coagulable lymph. In the *pericardium* was found a ſmall quantity of bloody *ſerum*, of a dark browniſh caſt. There were marks of inflammation on the ſurface of the heart, and ſome part of the coronary artery was oſſified. In the right ventricle, and in the pulmonary artery was a large concretion of the kind erroneouſly ſuppoſed a *polypus*, the upper part being white and ſizy, whilſt the lower had only the appearance of a dark coloured congealed blood: It was obvious that this concretion was formed after death. On the external ſurface of the left ventricle, near the *ſeptum*, was a tumor, which, on being cut into, was found to contain above half a ſpoonful of a dark, reddiſh coloured matter of the conſiſtence of *pus*, nor was there any doubt of its being produced by ſuppuration. This abceſs would have broken into the left ventricle had not the opening through the *ſeptum* been covered and ſhut up, on the ſide next that ventricle, by a cruſt, or *polypus*, of the ſhape, and about the ſize of half a large pigeon's egg, divided long-ways, ſo that the flat ſide lay towards the mouth of the abceſs, whilſt the convex ſide was turned towards the ventricle and occupied a ſpace in it. This, adds Sir John Pringle, was a true *polypus*; it cut tough or like the coagulated blood of aneuryſms of old ſtanding, nor was there any doubt, from its appearance, of its having exiſted there for a conſiderable time."

Now this cruſt or *polypus*, lying over an inflamed ſurface, had probably been formed by a ſecretion of the lymph from the inflamed veſſels;

and being formed in the cavity of the heart where there was a conſtant current of blood, the lymph of which it was compoſed, muſt, I think, have coagulated inſtantly on being ſecreted from the veſſels, otherwiſe it would have been waſhed off with the current; and as the coagulable lymph is not naturally diſpoſed to coagulate ſo inſtantaneouſly, it is probable that the diſeaſed veſſels here poſſeſſed the power of producing that change; and therefore, that as in dropſical habits, where the veſſels act weakly, the fluids exhaled are of a watery tenuity; ſo in inflammatory caſes, where the veſſels act ſtrongly, thoſe ſecreted fluids, in conſequence of that ſtrong action, acquire a more viſcid and a more coagulable nature.

And moreover, as it appears that the properties of the lymph exhaled upon ſurfaces, and into cavities, differ ſo widely in different circumſtances, and as we find that *pus* is often met with in ſuch cavities, without ulceration, is it not probable that *pus* itſelf is merely that lymph changed in its properties by paſſing through inflamed veſſels. The cavities of the *pleura, pericardium,* &c. are ſometimes obſerved to contain conſiderable quantities of *pus* without the leaſt mark of ulceration. Inſtances of which I have ſeen. In one patient I found three pints of pure *pus* in the *pericardium,* without any ulcer either on that membrane, or on the heart. In another, the cavity of the *pleura* of the right ſide was diſtended with a *pus* that ſmelt more like whey than a putrid fluid, and the lungs were compreſſed into a very ſmall compaſs; but there was no appearance of ulcer or eroſion, either on theſe organs or on the *pleura,* but only under the *pus* was a thin cruſt of coagulable lymph. In ſuch caſes it is manifeſt the *pus* muſt have been formed from the fluids; and as the exhalant veſſels at one time appear to ſecrete a mere water; at another a coagulable lymph; and in a third (when a little inflamed) they ſecrete that lymph ſo viſcid, and change its properties ſo much as to make it coagulate inſtantly on being ſecreted; ſo in like manner they may ſometimes, when more inflamed, have the power of converting the lymph into *pus*: and, according to the kind and degree of the inflammation, the *pus* may vary from the bland, viſcid, and inodorous nature, to that of the moſt thin and fœtid ſanies found in phagedenic and cancerous ulcers. And, if *pus* in theſe caſes is produced merely by a ſecretion, ſo likewiſe, it would ſeem probable, that even in abceſſes, where there is a loſs of ſubſtance, it is not the melting down of the ſolids that gives riſe to the *pus*, but the *pus* being ſecreted into the cellular membrane from its preſſure, and from other cauſes, deadens the ſolids and then diſſolves them, which is confirmed by obſerving, that even a piece of freſh meat, if put into an ulcer and covered up, is ſoon deſtroyed or melted down by the *pus*, which is thereby rendered more fœtid. And this opinion, that *pus* is made by a ſecretion, is ſtrengthened by obſerving that in its pure ſtate it is full of globules; in which circumſtance it agrees with milk, which is produced by a ſecretion, and not by a fermentation*.

Upon the whole then it appears, that the lymph contained in the lymphatic veſſels, and the fluids which moiſten the different cavities of the body, as the *pleura*, *peritoneum*, &c. inſtead of being a mere water, in healthy animals, are coagulable fluids, approaching to the nature of the coagulable lymph of the blood, of which probably they are a ſpecies, or are compoſed of a mixture of that lymph with water, that the proportions of that mixture vary from the dropſical habit, where the coagulable lymph is in a ſmall, and the water in a great proportion, up to the rheumatic or inflammatory habit, where the lymph abounds, and the water is in leſs proportion; and that in ſome caſes, the lymph, in paſſing through inflamed veſſels, is even converted into *pus*.

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* See Profeſſor Morgan's ingenious Diſſertation, de Puopoeſi.

C H A P. VIII.

Of the Manner in which the Lymph is ſecreted into the cavities, for their lubrication.

HAVING in the preceding chapter ſpoken of the properties of the lymph moiſtening the different cavities of the body, I ſhall in this conſider the manner in which that lymph is formed, or ſecreted from the maſs of blood.

The moſt generally received opinions concerning this ſecretion have been, that it was performed either by ſmall exhalant arteries, or elſe by pores on the ſides of the veſſels, which pores were believed to be organized.

But theſe opinions have been controverted by a celebrated anatomiſt*, who has endeavoured to prove that this ſecretion was not performed by exhalant arteries, or an effect of what is properly called organization, but merely by the thinner or more watery parts of the blood, filtrating or tranſuding through the inorganized interſtices between the fibres of our veſſels and membranes: ſo that, according to this idea, the fibres of our veſſels were cloſe enough to retain the *ſerum*, or the red globules, but not cloſe enough to prevent the water oozing out as through a ſieve, and the arguments with which this doctrine is ſupported, are as follow:

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* Dr. Hunter.

Firſt, The ready tranſudation of watery and other injections after death.

Secondly, The tranſudation of blood after death, but not during life; for during life he ſuppoſes the blood to be thickened by the coagulable lymph, but when that lymph is jellied, he concludes the blood is thereby made thinner, and therefore more capable of oozing through the inorganized interſtices, by which it could not paſs before.

Thirdly, The tranſudation of bile, which he thinks takes place in the living body, becauſe on opening a dead one we ſee all the neighbourhood of the gall-bladder tinged with this fluid*.

Such are the arguments brought in favour of tranſudation; but on a careful examination, they are not ſo ſatisfactory as thoſe which may be produced in defence of the opinion that theſe ſecretions are by organized paſſages, as I think will appear from the following obſervations.

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* See Dr. Hunter's Medical Commentaries, Part 1ſt. p. 40.

Firſt, Although fluids do tranſude on being injected into the veſſels of the dead body, yet we muſt not thence conclude that a ſimilar effect would certainly take place in the living, for it is probable, that "our fibres and "veſſels have a degree of tenſion which "they may loſe with life." Beſides, if tranſudation took place in the living body, it would ſeem to defeat the principal purpoſe for which the blood-veſſels were made, that is, the containing and conveying the fluids; and upon drinking a greater quantity than ordinary of watery liquors, inſtead of the liquors being carried to the kidneys or other emunctories, and thereby thrown out of the body as a redundancy, they would eſcape into the cellular membrane and occaſion an *anaſarca.* That this would be the caſe will appear the more probable, when it is conſidered how ſmall the fibres of our blood-veſſels muſt be, and therefore what millions of pores (did they exiſt) the water would be expoſed to from its entrance into the ſtomach, and its paſſage through the lacteals, the thoracic duct, the veins, the heart, the lungs and the arteries, before it reached the kidneys. So that were we in imagination to follow a drop of theſe liquors, according to the idea of tranſudation, we ſhould find it, firſt leaking through the ſtomach or through a lacteal, then being abſorbed, then eſcaping a ſecond time, and being again abſorbed, &c. an idea by no means conſiſtent with what we know of the works of nature, who, as a learned and ingenious author ſays of her, "*Operam* "*ſuam non ludit, neque quod actum eſt* "*agit denuo**." It is more probable therefore, that as the blood-veſſels are made to contain and convey the fluids, nature has taken care to conſtruct them properly to prevent this purpoſe being defeated.

Secondly, To ſuppoſe that the fluids which moiſten the different cavities of the body, as the *pericardium*, *pleura*, *peritoneum*, *tunica vaginalis*, &c. get into theſe cavities merely by tranſudation, is to ſuppoſe, not only that the ſmall veſſels in contact with theſe membranes have inorganized pores, but alſo that theſe membranes themſelves have the ſame juſt oppoſite to thoſe of the veſſels. Now if we admit inorganized pores at one part of thoſe membranes, we muſt admit them in all parts, and in the ſame degree: But as the blood-veſſels are circular, and touch thoſe membranes only by a ſmall part of the circle, the parts touched by the veſſels muſt be ſmaller than the interſtices between the veſſels, and the lymph muſt have fewer chances in favour of its leaking from the veſſels into the cavities, than of its oozing again from theſe cavities into the interſtices between the veſſels or into the cellular membrane; ſo that, if theſe membranes admitted of tranſudation, there would be no ſuch thing as a partial dropſy, for the water would run out at one part of the *pleura*, *pericardium*, *peritoneum*, &c. as faſt as it ran in by the other, and an *anaſarca* would always accompany an *aſcites*; which not being a fact leads us to believe, that thoſe membranes do not admit of tranſudation in living bodies, and that the fluids get into them not by inorganical, but by organized paſſages.

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* Dr. Gliſſon.

Thirdly, To prove more ſatisfactorily that theſe fluids are not filtrated from the blood merely by inorganical tranſudation, let us recollect the experiments related in the laſt chapter concerning the properties of thoſe fluids, which we found varied in different circumſtances of health. For, in inflammatory affections of the parts from which they were ſecreted, they aſſumed the appearance of the coagulable lymph of the blood, and formed a tough jelly; in animals in health they formed a jelly of a weaker nature; and in dropſical caſes they were almoſt a mere water, without the property of coagulation. Now if theſe fluids be ſo variable in their properties, it is manifeſt that the paſſages ſecreting them cannot be always unalterably the ſame, or inorganized; ſince at one time we find them ſecreting one fluid, and at another time ſecreting another; eſpecially as we ſometimes find them ſecreting a fluid very different from the blood, viz. *pus*. Which *pus* being found in cavities without any ulcer or eroſion, we muſt conclude it formed by ſomething more than a mere filtration; for we cannot ſuppoſe there ſhould be filtrated from the blood a fluid that was not in it. And if *pus*, which paſſes from the ſame pores, can only be accounted for by ſuppoſing theſe pores to be organical, in like manner is it not probable, that the ſecretion of the natural lymph is not a ſtraining through inorganical, but through organized paſſages?

Laſtly. It has been brought as an argument in favour of tranſudation in the living body, that blood tranſudes after death, and this has been explained on the ſuppoſition that the blood was thicker before the coagulation of the lymph. Which ſuppoſition appears ill-founded, when we ſpeak of the living body; for in former experiments* we have obſerved that this lymph, frequently at leaſt, rather thins than thickens the blood. If therefore the blood tranſudes in the dead and not in the living body, we ſhould rather attribute it to a change in the veſſels than in the blood, as is probable from a careful examination of that very fact which has been brought as the principal argument in favour of tranſudation, viz. the parts adjacent to the gall-bladder being tinged with bile; for any one who will take the trouble of ſtanding by a butcher, whilſt he kills a ſheep, will find, contrary to that gentleman's concluſion, that upon opening the animal immediately there is no appearance of the gall having tranſuded, for none of the parts ſurrounding the gall-bladder are tinged. But let the animal continue a day or two unopened, and then the gall will be found to have tranſuded, and to have tinged the neighbouring parts; as is the caſe in the human body by the time that we inſpect it.

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* See Exp. Inquiries, Part 1ſt.

Since then the gall bladder ſo readily allows of tranſudation after death, and not during life, is it not probable that there is in our membranes and our blood-veſſels a degree of tenſion, or a power of preventing the fluids oozing out of them, which power is loſt with life?

Upon the whole then it appears, that the interſticial lymph, or the fluid which moiſtens the different cavities of the body, being different from mere water, cannot be produced ſimply by tranſudation through inorganical interſtices; but that there are ſmall exhalant arteries, or organized paſſages, which not only tranſmit it from the blood, but change its properties, and adapt it to the office of lubrication, and likewiſe make it aſſume very different appearances in different circumſtances of health.

CHAP. IX.

An Examination of the Opinion, whether the common Veins do the Office of Abſorption.

AS there is a ſecretion upon the different ſurfaces, and into the different cavities of the body for the purpoſes of the conſtitution, ſo there is likewiſe an inhalation or an abſorption. For example; If food be taken into the ſtomach and inteſtines, it is there digeſted, and being converted into chyle, it is in that form taken into the blood-veſſels. If garlick be applied to the ſkin it gets into the body, and is ſmelt in the breath with as much certainty as when taken into the ſtomach, where its juices are abſorbed by the lacteals. So, likewiſe, terebinthinate medicines applied to the ſkin are ſoon ſmelt in the urine; and cantharides in a bliſter affect the urinary paſſages.

In the ſame manner fluids are taken from different cavities of the body into the vaſcular ſyſtem. Thus the water of an *aſcites* and an *anaſarca* are occaſionally taken up and carried by the blood-veſſels to the inteſtines and kidnies, and evacuated by ſtool or by urine. And the *pus* of an abſceſs is ſometimes abſorbed, and carried to diſtant parts of the body and there depoſited, or is evacuated by the inteſtines or urinary paſſages. So alſo fluids injected into cavities, as that of the cheſt or the belly of living animals ſoon find their way into the blood-veſſels. Theſe circumſtances are admitted by anatomiſts amongſt the unqueſtionable facts of phyſiology.

Nor do anatomiſts differ in their opinions about the mode in which theſe fluids are taken up, for it is univerſally allowed to be by abſorption, or that there are ſmall orifices adapted to imbibe them; the only queſtion is, what the veſſels are to which theſe orifices belong, whether, to the lymphatic ſyſtem, or to the common veins.

That the common veins did the office of abſorbing both the chyle and the lymph, was the opinion of anatomiſts before *Aſellius* diſcovered the lacteals; but after his time few doubts were entertained of the lacteals abſorbing, at leaſt, a part of that fluid. But moſt anatomiſts have been ſo tenacious of the old opinion as ſtill to believe, that the veins partly performed that office, or abſorbed ſome of the chyle and carried it to the liver.

As to the abſorption of the lymph; they have been ſtill more poſitive of its being performed by the common veins; nay even after the diſcovery of the lymphatic veſſels it occurred but to few, that theſe veſſels contributed in the leaſt to this abſorption. And no wonder, ſince, beſides the reſpect for the contrary opinion, becauſe it was tranſmitted from antiquity, anatomiſts thought themſelves poſſeſſed of many ſtrong arguments in favour of the common veins performing abſorption; and, as theſe arguments ſtill continue to have weight with ſome modern phyſiologiſts, we ſhall make a particular examination of them in this chapter.

Firſt. That the common veins ariſe from cavities, eſpecially in the inteſtines,

tines, and do the office of abſorption, is thought probable from injections into theſe veins in dead bodies having ſometimes paſſed into thoſe cavities, even in caſes where but little force was uſed. This is a circumſtance which has occurred in the experiments of the moſt eminent anatomiſts, both of the paſt and of the preſent age, ſo that there is no fact in anatomy in favour of which more reſpectable authorities might be produced. And yet whoever has made numerous experiments with injections, muſt be convinced how eaſy it is to be deceived by them in this matter. For the veins in dead bodies being eaſily ruptured, whenever we ſee injections get from them into cavities, we have reaſon to doubt whether theſe injections had paſſed by natural paſſages or by laceration of the ſmall veſſels; and whoever will examine the authorities that have been quoted in defence of this fact, will find that an equal degree of credit has been given to experiments made with ſuch coarſe materials as no experienced injecter will now believe could paſs through ſuch ſmall orifices *, as to thoſe injections which from their ſubtilty leave the point more doubtful. Beſides, as we found in the former chapter, ſuch changes are produced upon animal bodies by death, that membranes, which during life had been ſo tenſe as to prevent tranſudation, after death were ſo much altered, that in the gall-bladder, for example, they allowed the viſcid bile to paſs.

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* For example, Dr. Hales's injection of tallow, reſin and turpentine varniſh; which being injected, a part of the vermillion got into the bowels, although no greater force was uſed than that with which the blood circulates in the living body: but then it is probable that the veſſels are weaker in the dead than in the living animal.

Does it not therefore become doubtful, when an anatomiſt injects a cavity from a vein, whether (although he cauſe no rupture) he may not ſeparate the fibres already relaxed by death, in ſuch a manner as to imitate this tranſudation? And if one anatomiſt has been miſled when he concluded tranſudation took place in the living body, becauſe he found it in the dead body, ſo may they likewiſe, who have concluded veins aroſe from cavities in the living becauſe they had been able to puſh injections into ſuch cavities in the dead body. It muſt, therefore, I think, be allowed that ſuch experiments are at the beſt equivocal.

Another argument uſed in favour of veins ariſing from cavities, particularly from the inteſtines, is that ſome anatomiſts have affirmed that they have ſeen white chyle in the blood taken from the meſenteric veins. But this argument will appear very inconcluſive, when the reader recollects, that the *ſerum* of the blood let out from the veins of the arm is ſometimes white, which muſt ariſe from ſome other cauſe than theſe veins abſorbing chyle. And, therefore, if that appearance in the brachial veins, can be otherwiſe accounted for, than by abſorption, we are left in doubt whether in thoſe inſtances, where anatomiſts obſerved ſuch a fluid in the veins of the meſentery, it had been owing, not to thoſe veins abſorbing it, but to their receiving it from the arteries. All the *ſerum* of the body being now and then as white as milk*.

A third argument produced in ſupport of abſorption by the common veins is taken from the ſtructure of the *penis*, whoſe veins ariſe from its cells; which cells, however, are now allowed to be particular organizations, and very different from thoſe of the cellular membrane, and the blood is believed not to be abſorbed, but to be impelled from theſe cells into thoſe veins; and the argument is now given up even by ſome of thoſe who were once the moſt ſtrenuous in its favour*—It need not therefore be here dwelt upon.

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* Inſtances of which may be ſeen in the firſt Part of theſe Exp. Inquiries.

Ligatures, or compreſſion on the large veins, have been conſidered as furniſhing a fourth argument in favour of theſe veins ariſing from cavities, and doing the office of abſorption. Thus the ſwelling of the legs in pregnant women, and in caſes where tumors have been ſeen near the veins, has been explained from the *uterus* in the one caſe, and the tumors in the other, occaſioning ſuch compreſſion, as to prevent the return of the venous blood. But there are two circumſtances which make this argument far from being ſatisfactory. — Firſt, the lymphatic veſſels run near ſuch veins, and it is doubtful whether the lymph may not be retained in the limbs more by the compreſſion of theſe veſſels, than by that of the veins. Secondly, The compreſſion of a vein, may, by ſtopping the return of the blood, not only diſtend the ſmall veins, but the ſmall arteries, and the exhalants may be ſo dilated, or ſo ſtimulated, as to ſecrete more fluid than they did naturally. In this way, perhaps, the ligature which Dr. *Lower* made on the *cava inferior* of a dog occaſioned the *aſcites**.

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* See Profeſſor Monro's State of Facts.

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* De corde, cap. 2, p. 122.

An experiment which I have repeated, but my ſubject did not live ſo long as his, for mine died in half an hour, and had only a very little water in the *abdomen*.

Lower has related another experiment which has frequently been quoted by writers on the dropſy; that is, where he tied the jugular veins of a dog, and the dog's head became dropſical. Now were this an experiment which always ſucceeded it would be more deciſive, for when the whole *cava* was tied, no part of the blood being able to return, all the veſſels below, not only the ſmall veins, but the ſmall arteries, muſt have been extremely diſtended. Whereas in this experiment no ſuch thing would take place, becauſe the jugular veins ſo frequently communicate with other veſſels, that there would ſtill be a regreſs allowed to the blood: If the neck therefore became œdemitous, it would appear more likely to have been occaſioned by the ligature on the veins. But what ſhews that there muſt have been ſome fallacy in *Lower*'s experiment, is, that theſe veins have ſince been frequently tied without an *œdema* being produced, or any ſigns of extravaſated lymph. Thus, in not one of the experiments which I made on theſe veins in living dogs (as related in the firſt part of theſe Experimental Inquiries) was this effect ever produced: And Baron *Van Swieten* tied up both the jugular veins, and though he kept the dog four days afterwards, did not obſerve him any way incommoded*. In one dog I even cut out both the external jugulars, and kept him near a twelvemonth without obſerving the leaſt ſymptom of dropſy. I ſhould therefore ſuppoſe, that in *Low-*

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* Comment in Boer. Aph. § 170, p. 266.

er's experiment, not only the veins, but the lymphatic veſſels which lie near them had been tied; in which caſe the lymphatics would burſt and occaſion theſe ſymptoms. But in my experiment I took care to ſeparate the vein from the lymphatics.

Theſe arguments, therefore, in favour of abſorption being performed by the common veins, which are brought from experiments where ligatures were made on large veſſels, ſeem likewiſe to be liable to fallacy.

A fifth argument is taken from the ſtructure of the *placenta*, where it has been concluded there are no lymphatics; and yet there muſt be abſorption, and not a communication of the veſſels; neither of which arguments are deciſive. For, there may be lymphatics in the *placenta*, though not yet diſcovered. Or there may be ſmall veſſels paſſing from the mother to the *fœtus*, though not yet injected.

A ſixth argument is furniſhed by the experiments of ſome authors, in which experiments it is affirmed, that fluids injected into the inteſtines were ſoon afterwards diſcovered in their meſenteric veins. The experiment related by the ingenious *Kauw Boerhaave*, has been the moſt depended upon in this matter*. In which experiment, water was injected into the inteſtines, and thoſe inteſtines being compreſſed, the water was afterwards obſerved to run from the veins; but that ſome fallacy had crept into this experiment is now probable, from its having been repeated ſeveral times in a very ſatisfactory manner[*], without being attended with the like ſucceſs. The learned M. *de Haller*, indeed, in comparing theſe arguments, ſays, that in ſuch caſes where authority ſeems to ballance authority, he chuſes rather to adopt the opinions of thoſe who affirm, than of thoſe who deny the fact. For, as he obſerves, this experiment may eaſily fail of ſucceſs; but if it has ever ſucceeded, we ſhall not eaſily find another way of accounting for it, except by allowing that theſe veins open into the inteſtines[†]. But with due deference to the opinion of this excellent author, *Kauw Boerhaave*'s experiment is not ſo concluſive as thoſe alluded to above; for in his, the dog was opened immediately after death, and water being injected into his ſtomach, that water was ſeen firſt to dilute the blood, then to waſh it from the *vena portarum*, and the experiment was continued a conſiderable time by means of preſſing the ſtomach, which preſſure furniſhes a ſtrong preſumption that the water did not get into the veins by abſorption but by a laceration, eſpecially as the experiment continued to ſucceed for ſome hours after death; whereas abſorption always ceaſes long within the firſt hour*. This argument, therefore, which has been conſidered as ſo ſtrong in favour of abſorption by the common veins, is liable to objections.

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* See de Perſpir, § 469, 470, 471.

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[*] Dr. Hunter's Medical Comm, Ch. v.

[†] Elem. Phyſ. L. 24, S. 2, § vi.

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* K. *Boerhaave's* words (after mentioning that the blood was waſhed out by the wound made in the auricle of the heart) are as follow: "Tandem "pura aqua tædioſo labore *per horas*, leniſſime "immittere aquam & premere ventriculum con- "tinuavi donec pallerent omnia vaſa ſanguine or- "bata per reſorptam aquam"—See de Perſpir. § 470.

And laſtly, A ſeventh argument uſed in favour of common veins abſorbing, was, that many animals were deſtitute of any other veſſels which could do that office. This was ſuppoſed to be the caſe with birds, fiſh, and amphibious animals; all of which ſome anatomiſts did not heſitate to affirm muſt want every part of the lymphatic ſyſtem, and with great appearance of reaſon; ſince in the ſmalleſt quadruped they could eaſily find either lacteals or lymphatic glands upon the meſentery, but in the largeſt bird, or fiſh, neither lacteal veſſel, nor conglobate gland could be ſeen. And if theſe animals (ſaid they) be without the lymphatic ſyſtem, abſorption in them muſt be performed by other veſſels, viz. the common veins; and if in them the common veins can do the office of abſorption, why ſhould not they likewiſe

wiſe perform it in the human body, where ſuch veins equally exiſt *? But this argument is overthrown by the lymphatic ſyſtem being now diſcovered in all theſe animals.

Such are the arguments produced in favour of the common veins doing the office of abſorption, a doctrine which has lately been eſpouſed by that excellent anatomiſt, Dr. *Meckel*, to whoſe obſervations, though agreeing with ſome already mentioned, it may be neceſſary to pay a particular attention.

Dr. *Meckel*'s concluſions in favour of this doctrine, are made entirely from injections in dead bodies. For, having filled the common veins by injecting mercury into the lymphatic glands, into the excretory ducts of the breaſts, into the *veſicula ſeminalis*, into the hepatic ducts, and into the urinary bladder; he concludes, that the veins open into theſe parts in the living body to abſorb from them*.—A concluſion which is already proved to be liable to conſiderable objections, as we never can be ſure whether our injection, in getting from theſe cavities into ſuch veins, had gone by a natural, or by a forced paſſage. Dr. *Meckel* does indeed mention, that there were no marks of an extravaſation in his experiments — Perhaps it might have been too ſmall for obſervation. Nay, we have even reaſon to believe, that as the ſmall veſſels of the human body are very cloſe to one another, our injection may ſometimes burſt from one into another lying in contact with it, without diſtending the cellular membrane which lies between them. A circumſtance which I have ſeen happen even on the meſentery of a turtle, where upon injecting the lacteals I have more than once made the mercury paſs into the common veins; but in all theſe caſes, on a careful examination, I found it was by rupture, as could readily be diſtinguiſhed in this animal, whoſe meſentery is extremely thin and tranſparent. And that it actually was ſo, and not by a natural paſſage, muſt be evident to every anatomiſt, who conſiders that this is an experiment which does not always ſucceed on the meſentery of the turtle, where, if there were natural paſſages, or if the lacteals opened into the veins, the mercury would probably run with great facility.

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* See Prof. Monro's Obſ. Anat. Phyſ. p. 57 — Dr. Haller's Elem. Phyſ. L. 24, Sect 2, § 3, p. 66 and 67.

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* See his Nova Experimenta & Obſervationes, Berol. 1772.

And the very ſame circumſtance which Dr. *Meckel* has obſerved of a lymphatic gland, has happened to me ſome times on injecting theſe glands in diſeaſed caſes; that is, I have filled the common veins, and in ſome inſtances, where I looked for it, I could diſtinguiſh the extravaſation very readily, and therefore concluded, that in the other caſes where the veins were filled, that it was alſo by an extravaſation, though a more obſcure one. I ſhould thence ſuſpect, that in Dr. *Meckel's* experiment, where he filled the common veins by injecting into the lymphatic veſſels of a diſeaſed gland, a ſimilar deception had taken place; eſpecially as the force applied was conſiderable, he having uſed a column of mercury eighteen inches high.

And the ſuppoſition of the red veins opening into a lymphatic gland, appears improbable from an obſervation concerning the ſtructure of the glands, for which we are indebted to Dr. *Meckel* himſelf, viz. that they are made of a convoluted lymphatic veſſel*. Now to ſuppoſe a lymphatic, which is a veſſel given to abſorb, ſhould itſelf, even when convoluted, have a common vein opening into it for abſorption from its cavity, is not, I think, conſiſtent with what we know of nature's operations, who to repeat the words of *Gliſſon*, "*Operam ſuam non ludit, neque quod* "*actum eſt, agit denuo.*"

Similar objections might be made to the other experiments related by this very ingenious author; but enough I think has been ſaid to ſhew how cautious we ſhould be in making concluſions, with reſpect to the paſſages of the living body, from ex-

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[*] Epiſt. ad Hallerum.

periments made on the dead, where from the weakneſs of the veſſels, and other circumſtances, we are ſo liable to be deceived*.

Thus, on taking a review of the doctrine, that the common veins are the inſtruments of abſorption, that doctrine appears to have no other ſupport than reſpect for the authority of our predeceſſors, for all the arguments in its favour it are liable to conſiderable objections. Let us next therefore enquire, whether ſome other part of the human body may not do that important office.

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* Dr. *Hunter* and Dr. *Monro* found in their experiments, that injections readily burſt from the arteries into the lymphatic veſſels, by the intervention of the cellular membrane; theſe experiments they at firſt conſidered (as Dr. *Meckel* does his) as proofs of their having filled the natural paſſages; but more careful obſervations ſeem to have now convinced the former of theſe gentlemen that ſuch concluſions are fallacious, and he now thinks that the injection may have burſt into the ſides of the lymphatic veſſel. See his Medical Commentaries, p. 57.

C H A P. X.

On the Uſe of the Lymphatic Syſtem.

THIS ſyſtem, in all animals, we have found, conſiſts of a trunk or thoracic duct, and of two extremities, namely, the lacteals and the lymphatic veſſels. The lacteals can be traced from the thoracic duct to the inteſtines, through coats of which they paſs, and open into their cavities by patulous orifices, in order to abſorb the chyle and to tranſmit it through the thoracic duct to the blood-veſſels. That this is their uſe, has never been queſtioned, ſince the firſt diſcovery of thoſe veſſels,

ſels, from its always admitting of eaſy demonſtration, that is, by giving an animal milk, and then opening him a few hours after, in which caſe the ſame fluid that is ſeen in his inteſtines can likewiſe be ſeen to have got into his lacteals—a ſatisfactory proof of the lacteals beginning from the inteſtines.

After thus being convinced, that the uſe of one branch of the ſyſtem is to abſorb, we cannot at firſt ſight but wonder, that any anatomiſt ſhould have heſitated to attribute a ſimilar office to the other. Nevertheleſs ſome anatomiſts have been led to aſcribe to the lymphatics a very different uſe to what they found the lacteals perform; particularly ſince the time that *Nuck* firſt made his experiments, in which he thought he injected theſe lymphatic veſſels from the arteries, and therefore concluded, that they had no other uſe than as correſpondent veins to return the lymph from ſuch arteries as were too ſmall to admit the red blood, or the *ſerum*. And in this opinion anatomiſts were confirmed by the theories of *Leeuwenhoeck* and of *Boerhaave*, concerning the gradation in the ſeries of the globules of our fluids, and of the ſizes of the veſſels deſtined to convey them; thence the idea of the lymphatic veſſels being ſmall veins continued from arteries became ſo general amongſt phyſiologiſts.

But although this idea was ſo commonly received, yet there were ſome phyſiologiſts who reaſoned better on the ſubject; and amongſt the firſt of theſe was *Gliſſon*, who, in a book publiſhed the very year after that in which *Bartholin* wrote upon the lymphatics, attributes to thoſe veſſels the office of carrying back to the blood-veſſels the lymph which had lubricated the cavities of the body*.

M. *Noguez* likewiſe, in a chapter where he mentions the name of Dr. *Gliſſon*, ſpeaks of the uſe of the lymphatics, as follows: "Ils reportent la "lymphe dans les vaiſſeaux ſanguins "ou dans les veins, il y en a dans toutes "les parties du corps, ils repompent "la matiere lymphatique qui s'evacuë "par les arteres, on peut les nommer "conduits abſorbans;" and again in another place, he ſays, "ils recoivent "la lymphe ſubtile qui ſe repand ſur "la ſurface de toutes les parties, et "dans les differentes cavitez du corps, "ils la reportent au ſang†.

Hambergerus alſo ſeems to have had this idea of their office, for he ſays,

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* de Hepate, Cap. XLV. edit. Lond. 1654.

† Anatomie de l'Homme, 2d Edit. Cap. viii.

"ex omnis generis cavo, humidum li-
"quidum vehente, ſive ſit arteria, ſive
"vas ſecernens, vel excretorium, vel
"aliis uſibus deſtinatum, vaſa lym-
"phatica oriuntur*."

Frederic Hoffman has been ſtill more explicit on this ſubject, and has expreſſed the doctrine of the lymphatics being abſorbents very completely, in his Medic. Ration. ſyſtem, lib. 1, ſect. 2, cap. 3; where he ſays,

"§ 2. Duplex eſt origo vaſorum
"lymphaticorum, quaedam ex ipſis
"arteriis prodeunt, alia ex poroſa &
"celluloſa partium ſubſtantia naſcun-
"tur.

"§ 4. Lymphatica, quæ ex partium
"ſubſtantia oriuntur, aquoſi ſucci nu-
"tritii partem reſorbent, ac revehunt
"ad cor.

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* Phyſiol. Med. § 469.

"§ 7. Revehunt vero omnia lymphatica ex univerſo corpore lympham ſuam ad capſulam lumbarem & chyliferum ductum, in quam ſe exonerant.

"§ 11. Ad facilitandum lymphæ regreſſum vaſa hæc valvulis inſtructa ſunt, & quidem ſigmoideis, numeroſioribus & anguſtioribus, quæ quidem lympham libere tranſmittunt, impediant tamen quo minus regurgitet."

This opinion of the lymphatics being a ſyſtem of abſorbents has been adopted and ſupported with additional arguments, firſt by Dr. *Hunter*, and afterwards by Dr. *Monro*, who, beſides ſhewing the fallacy of the experiments brought in favour of the common veins doing the office of abſorption, have advanced the following to prove that the lymphatics perform it.

Firſt, Their great analogy with the lacteals, with which they agree in their coats, in their valves, in their manner of ramifying, in their paſſage through the lymphatic or conglobate glands, and in their termination in the thoracic duct, and, in ſhort, in every circumſtance with regard to their ſtructure; and thence it is probable they alſo agree with them in their uſe. And as the lacteals are known to begin from the ſurface of the inteſtines, and to be the abſorbents of theſe parts, the lymphatics may begin from the other cavities of the body, and may abſorb the fluids which had lubricated thoſe cavities.

Secondly, The paſſage of the venereal, variolous, and other poiſons into the conſtitution; theſe poiſons firſt making an ulcer, and then being abſorbed along with the matter of the ulcer and infecting the whole body. That in ſuch caſes they are not abſorbed by the common veins, but by the lymphatics, appears from their inflaming theſe lymphatics in their courſe, and by their generally inflaming a conglobate gland before they enter the ſyſtem; a ſtrong argument in favour of their being taken up by the lymphatic veſſels, which paſs through theſe glands in their way to the thoracic duct*.

Theſe two are the principal arguments by which the doctrine of the lymphatics being a ſyſtem of abſorbents has been ſupported. Experiments made by injections in the dead body, where ſuch injections have been forced from the arteries into the cellular membrane, and from the cellular membrane into the lymphatics, have been likewiſe brought in favour of this doctrine, but improperly, and being now given up by thoſe who advanced them*, they need not be dwelt upon here.

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* See Dr. Hunter's Medical Commentaries. See alſo Dr. Monro, de Vaſis Lymph Valv.

But our experiments related above, furniſh another argument in favour of the lymphatics being a ſyſtem of abſorbents; for, in chapter the ſeventh we have mentioned, that in theſe experiments we have always found the fluids contained in the different cavities of the body, and that contained in the lymphatics exactly agreeing with one another, in their tranſparency, in their conſiſtence, &c. And in animals in health, we likewiſe found, when the one jellied on being expoſed to the air, the other did ſo too; and in the animal reduced by low diet where the properties of the one were altered, thoſe of the other were ſo likewiſe, and exactly in the ſame manner. So that we now ſeem to have obtained as deciſive an argument in favour of abſorption by lymphatics, as we before had of that by the lacteals; for the lacteals were concluded abſorbents from their being found to run from the inteſtines filled with a fluid ſimilar to what was in the cavity of the gut; ſo we ſeem here to have the ſame reaſon for believing that the lymphatics abſorb from cavities, becauſe they are found to contain a fluid exactly ſimilar to what is obſerved in theſe cavities; a ſtrong argument that the fluid had paſſed from ſuch cavities into theſe lymphatics by abſorption.

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* See Dr. Hunter's Medical Commentaries, p. 57.

Such then ſeems to be the purpoſe for which the lymphatic veſſels were provided, that is, to do the office of abſorption, an office of the greateſt importance to the animal; no wonder therefore, that there ſhould be a ſyſtem ſet apart for performing it, and not only in man and quadrupeds, but alſo in birds, fiſh, amphibious animals, and perhaps even in inſects of the moſt perfect kind.

CHAP. XI.

An Examination of the Opinion, whether ſome of the Lymphatic Veſſels may not be continuations of the ſmall Arteries.

I HAVE already obſerved, that ſoon after the diſcovery of the lymphatic veſſels, *Gliſſon* and others ſuſpected that they aroſe from the cavities of the body to take up the fluids exhaled from the blood-veſſels; but, at the ſame time another opinion was entertained by ſome anatomiſts, namely, that a part of the lymphatics were reflected from the ſmall arteries to which they correſponded, in the ſame manner as the common veins belong to the arteries carrying red blood.

In this opinion, that the lymphatics were only veins, anatomiſts were confirmed from experiments made by injections; particularly the blowing air into the arteries of the kidney, ſpleen, &c. and ſeeing it return by the lymphatics*; a fact that has ſince been proved to be owing to the air having burſt from the arteries into the cellular membrane, and ſo having got into theſe veſſels, and therefore by no means proving a direct communication between thoſe arteries and the lymphatics†.

Other injections, likewiſe, ſuch as mercury, water, &c. having been thrown into arteries, and afterwards having got into the lymphatics, have been mentioned

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[*] Nuck, Adenog. cap. 4, and 6.

[†] See Profeſſor Monro de Venis lymph Valvul.

tioned as ſo many proofs of a direct communication: but greater experience with injections has convinced ſome of the more accurate amongſt later anatomiſts, of there likewiſe being a fallacy in theſe experiments; or of the fluids having got from the arteries into the lymphatics, not by paſſages which were natural to the living body, but by ſuch as were the effects of laceration in the dead one. The preſent Profeſſor *Monro* has diſtinguiſhed himſelf in this ſubject: from his obſervations† and thoſe of Dr. *Hunter**, the notion of the lymphatics being continued from arteries ſeems to be very fairly exploded. And it is made probable, that the injections in dead bodies had miſ-led their predeceſſors, who had not been ſufficiently aware, that theſe injections might poſſibly have paſſed, not by natural, but by forced paſſages.

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† de Ven. Lymph. valv.

* Medical Commentaries.

CHAP. XII.

On the ſtructure of the Villi *of the Inteſtines, and the manner in which Abſorption is performed.*

THE term *Villi*, applied to the very ſmall proceſſes of the internal coat of the inteſtines, conveys an improper idea of their figure in the human body. In many quadrupeds indeed they are cylindrical, or like hairs or wool*; but in the human ſubject they are broad and flat; and when viewed with a microſcope they look like the *valvulæ conniventes* in miniature,

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* I have ſeen them of that ſhape in the dog, cat, lion, and the aſs.

ture, or are ſmall folds of the internal coat: So the accurate *Lieberkuhn* has painted them[†].

The whole ſurface of the alimentary canal is covered with theſe proceſſes; but in the large inteſtines they are ſo very ſhort, that to the naked eye the ſurface of theſe inteſtines appears ſmooth; thence the learned *Albinus* has conſidered them as having no *villi*[*], which is true in one ſenſe only, viz. that their inner coat does not appear ſhaggy, but ſpungy or cellular; yet the partitions between theſe cells are ſimilar in ſtructure to the *villi* of the ſmall inteſtines.

The appearance of the villous coat is very different in different parts of the alimentary canal.

In the *æſophagus* the *villi* are ſmall and not ſo full of veſſels, and are of the cylindrical or conical ſhape.

[†] de Villis Inteſtin. Tab. i.

[*] Anotat. Academic, Lib. vi. Cap. viii.

At the upper part of the ſtomach the villous coat appears in a microſcope like a honey-comb, or like the *reticulum*, or ſecond ſtomach of a ruminant quadruped, in miniature; that is, full of ſmall cells, which have thin membranous partitions. Towards the *pylorus* theſe partitions are lengthened ſo as to approach to the ſhape of the *villi* of the *jejunum*.

The *villi* of the *jejunum* are thin folds conſiderably broader than they are long, and when not injected they are very flat, ſo as to reſemble *valvulæ conniventes* in miniature, but are ſo ſmall that they can but juſt be diſtinguiſhed by the naked eye.

In the *ileon* the *villi* become rather longer in proportion to their breadth. In the *colon* and *rectum* the villous coat is like the upper part of the ſtomach, honey-combed or cellular. Theſe facts are only evident after a minute injection; for in the uninjected ſtate the *villi* collapſe, ſo that their figure cannot be diſtinguiſhed. The partitions between the cells of the internal coat of the *colon*, and of the ſtomach, being each very vaſcular, and agreeing with the *villi* of the *jejunum* in every circumſtance except magnitude, are to be conſidered as having the ſame uſe, namely, to abſorb, as will appear probable hereafter.

Upon each of the *villi* is an artery and a vein which make a net-work of branches, as is well expreſſed in the ingenious *Lieberkuhn*'s plate*.

Beſides arteries and veins, it is probable that the *villi* have nerves diſtributed to them.

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* de Villis Inteſtinorum, Tab. 1, Icon. 2.

They likewiſe have lacteals, which, according to *Lieberkuhn*, open on the extremities of the *villi*, ſometimes by one and ſometimes by more orifices.

Each *villus*, the ſame author thinks, has an *ampulula*, into which theſe orifices lead, and from the other ſide of the *ampulula* the lacteal paſſes through the coats of the inteſtines. This is the only circumſtance, concerning theſe parts, in which I ſhould differ from this very accurate obſerver, whoſe experiments, in ſupport of his opinion about this *ampulula*, ſeem to be liable to fallacy. Of this I was firſt perſuaded from obſervations made on fiſh, birds, and amphibious animals, in all

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† An account of ſome preparations exhibiting theſe facts, was printed in the Phil. Tranſ. Vol. 59.

of which I can demonſtrate, that the *villi* have a net-work of lacteals as well as a net-work of arteries and veins.

That the *villi*, in ſome fiſh, have a net-work of lacteals, I have diſtinctly ſeen in the turbot, where I have injected the lacteals with mercury, which readily runs from thoſe veſſels into the *villi*, and makes them turgid and erected. In the ſame way, I have likewiſe ſeen a net-work of lacteals on the *villi* of a turtle, where theſe *villi* are of a different ſhape, and, in ſome parts of the gut are cellular, or honey-combed, ſomething like the lower part of the human ſtomach, only the partitions of the cells are here much larger.

In birds the experiment is more difficult, becauſe their lacteals are full of valves, and their *villi* are ſmall, compared to thoſe of the turbot, nevertheleſs I have ſucceeded in getting the valves to give way, ſo as to fill a few of their lacteals diſtinctly enough to be ſeen to divide into branches upon the *villi*, and therefore to prove that they do not form a bag or *ampulula**.

Since therefore a net-work of lacteals is found upon the *villi* of all theſe animals, from analogy we ſhould ſuſpect the ſame in the human ſubject, whoſe *villi* are of the ſame ſhape, that is, broad and flat, which figure would appear not a proper one for an *ampulula*.

The experiments from which the ingenious *Lieberkuhn* was perſuaded there was an *ampulula*, were; Firſt, The *villi* appearing turgid with milk which had curdled in them, in ſuch ſubjects as had taken milk juſt before their death*. But whoever has made experiments with injections muſt be convinced of its being difficult to diſtinguiſh cluſters of ſmall veſſels from bags, when theſe veſſels are not filled with fluids of a brighter colour than milk or chyle; and even in thoſe caſes where ſuch veſſels were filled with vermillion (which is ſo much more vivid and diſtinguiſhable) ſome anatomiſts have been miſ-led; particularly concerning thoſe *corpora globoſa* in the kidney, which have been conſidered as bags or *cryptæ*. But I have repeatedly obſerved and have now by me ſome preparations which prove that theſe *corpora globoſa* are not uniform bags, but convoluted arteries, which comes near to the idea that *Ruyſch* had of them. Some ingenious anatomiſts have warmly eſpouſed a contrary opinion, and have not only ſuppoſed the kidney to have

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* See Philoſ. Tranſactions, Vol. 59, p. 213.

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* de Villis Inteſtinorum. § 2, 3.

follicles, but moſt other glands of the body, particularly the breaſt or *mamma,* and the ſalivary glands. But that they likewiſe have been deceived by a cluſter of ſmall veſſels will appear probable, when we conſider that the *corpora globoſa* in the kidney, which have by ſo many been pronounced bags or *follicles,* are only ſmall veſſels cluſtered together, or convoluted. And on making a variety of experiments on theſe other glands, I think it evident in what manner the deception has happened to thoſe ingenious anatomiſts; namely, when the excretory ducts of the breaſt, for example, are injected with vermillion and painter's ſize, the ſmall *acinæ* of which that gland conſiſts, are made extremely red, and ſuch a preparation being dried, the *acinæ* appear as large as pins heads, ſo that the breaſt has been ſuſpected to have *follicles* of that magnitude; but on injecting the breaſt with mercury, which is a brighter ſubſtance, and better contraſted to the dried fibres, I have diſtinguiſhed, what in the other preparation might be miſtaken for a bag, was here evidently no more than the extremity of the excretory duct, terminating in one of theſe *acinæ*, and dividing into a number of branches ſo ſuddenly as to come near to *Ruyſch*'s deſcription of the *penicilli* of arteries; but the ſmall branches, into which this extremity of the duct divided, were ſo cloſe to one another, that in the preparation where they were filled with ſize and vermillion, they could not be diſtinguiſhed, but in that where they contained mercury, it evidently appeared, that in each *acina* of the magnitude of a pin's head, there were a conſiderable number of branches, but ſo ſmall as not eaſily to be ſeen with the naked eye.

The ingenious *Lieberkuhn* has mentioned another experiment, from which he was not only perſuaded that the lacteals formed an *ampulula* upon the *villi*, but that this *ampulula* was filled with a ſpongy ſubſtance. This experiment he made by inflating the *villi* by the arteries and the veins, and upon drying the inteſtine and cutting the *villi* acroſs he obſerved them ſpongy*. But this is an appearance which may be as well explained, from knowing that each *villus* contains a net-work of ſmall arteries and veins which, being inflated, might occaſion the *villi* to aſſume a ſpongy appearance.

Since then the experiments from which the *villi* of the human ſubject were ſuppoſed to contain an *ampulula* are ſo equivocal, and ſince the *villi* can be proved in the other claſſes of animals, viz. in birds, fiſh, and the *amphibia*, to have net-works of lacteals as well as of arteries and veins, the probability is in favour of their having the ſame ſtructure in the human ſubject. But the difference between us is inconſiderable, for it may be nearly the ſame thing whether there is a bag filled with a ſponge, or a *plexus* of veſſels.

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* de Vill. Inteſt. § 8.

I have ſome preparations by me, adapted to the microſcope in *Lieberkuhn*'s manner, in which I think I can clearly ſhew the orifices of the lacteals on the extremities of the *villi*, where there appears, as he has deſcribed, ſometimes to be one, and ſometimes more orifices*. My preparations were made by injecting into both arteries and veins a thin ſize, or glue, coloured with vermillion; when this was not puſhed to great minuteneſs the *villi* appeared exactly as *Lieberkuhn* has painted them, with a net-work of arteries and veins on each, and when examined with a microſcope no orifices could be diſtinguiſhed, but each *villus* appeared to have a ſmooth edge. Yet in ſome part of the *ileon* where the injection had run more minutely, the *villi* appeared erected, and inſtead of being broad and thin were more round and cylindrical, and the extremity ſeemed ſpongy and porous, whilſt all the ſides of the *villus* were perfectly ſmooth and uniform. And moreover as in theſe preparations the orifices only appeared when the *villi* were completely erected, I think this circumſtance points out the uſe of the *villi*.

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* de Villis Inteſt. § 3.

It might be here objected that theſe were only lacerations of the *villi*, but I am perſuaded they were not, from having, on repeatedly examining them, obſerved the pores or orifices very diſtinct and empty; whereas, were they lacerations, I think, I ſhould have ſeen the injection in them, as the *villi* were ſo much diſtended by it.

It has long been obſerved by phyſiologiſts, that abſorption takes place only in living animals, and not in the dead; for if an inteſtine in a dead animal be filled with milk, none of that milk will get into the lacteals; but in the living animal, the milk will readily be abſorbed. This I think may be explained from what is above obſerved of the orifices of the lacteals appearing to open when the *villi* are erected, ſomething like which may take place in the living animal; that is, whenever abſorption is to be performed, the blood-veſſels of the *villi* may become turgid, and the orifices of the lacteals may then ſtand rigidly open, and be capable of attracting, like capillary tubes made of hard ſubſtances. But in the dead body the *villi* being emptied of blood, the coats of the lacteals, being ſoft, collapſe, by which means their orifices are cloſed, and they are thence made incapable of attracting the chyle, or of abſorbing.

It is obſervable, that thoſe parts of the ſkin which are intended to have more ſenſibility than the reſt, have thoſe proceſſes called *villi* moſt remarkably; this is evident, when after a minute injection we compare the tips of the fingers, the lips, the *glans penis*, with other parts of the ſkin; and this is ſtill more obſervable in the tongue whoſe *papillæ* are the inſtruments of taſte. In theſe inſtances ſome phyſiologiſts have ſuſpected that the blood-veſſels were ſome way ſubſervient to the nerves for ſenſation, an opinion which I think is very probable; and the uſe of the *villi* of the ſkin, agreeably to their opinion, ſeems to be as organizations of veſſels to become more turgid at particular times, by which turgeſcency the extremities of the nerves are made more capable of doing their functions; and agreeably to this idea it is obſervable that when we attempt to taſte any thing extremely grateful, the *papillæ* of the tongue can be ſeen to become erected*.

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* The *papillæ* of the tongue in the human ſubject appear to the naked eye, when they are not minutely injected, quite ſmooth, but on a minute injection each of theſe *papillæ* appears covered with ſmall vaſcular proceſſes or *villi*; ſo that in ſuch a tongue every one of the *papillæ* ſeems in the microſcope like a bunch of fibres, or rather like a ſheaf of corn—Some preparations of which, adapted to the microſcope, I have now by me. The learned Albinus ſeems not only to have obſerved this, but to have had the ſame idea of the uſe of theſe proceſſes which he calls tubercles, and has painted them like thoſe little eminences that appear upon a nipple, but I find them much longer. See his Annot. Acad. Lib. 1, cap. xv.

And as thoſe *villi* of the ſkin ſeem to be organizations capable of that turgeſcency which is neceſſary to adapt the ſentient extremities of the nerves to receive impreſſions, ſo I ſuppoſe the *villi* of the inteſtinal tube are able to exert a ſimilar erection or turgeſcency, in order to make the ſmall abſorbents ſtand rigidly open, and thereby act like capillary tubes of glaſs or other hard ſubſtances: And perhaps ſuch membranes as the *pleura*, *peritonæum*, &c. may be without *villi*, becauſe ſuch proceſſes would be leſs proper for affording the ſmoothneſs of ſurface required for the motion of one *viſcus* upon another: but to anſwer the ſame purpoſe they may have a network of blood-veſſels ſurrounding the abſorbing pores, which reticulation, by its turgeſcency, may make the pores ſtand rigidly open as thoſe we have obſerved upon the *villi*. But this being a leſs perfect organization,

tion, and uſed here, merely becauſe the more perfect, or villous, would be incompatible with the motion of the *viſcera* upon thoſe membranes, may, for that reaſon, be more liable to fail in doing its office, and thereby occaſion dropſies of thoſe parts; nothing like which ſeems to happen to the *villi*, which do not, as far as we know, ever fail in abſorbing chyle ſo as to occaſion a diſeaſe.

The orifices of the lacteals and lymphatics, therefore, by acting as capillary tubes, in conſequence of a particular organization near their beginnings, are capable of abſorbing the chyle and lymph; and as a capillary tube of glaſs being put into a baſon of water will attract the water to a conſiderable height above the ſurface of that fluid; ſo the animal tubes or abſorbents, merely by their attractive power, may not only imbibe but convey the fluid at leaſt as far as the firſt pair of valves, whoſe diſtance from the orifice of the abſorbents is probably very ſmall. But whether the force of attraction extends much farther than the firſt pair of valves, may be a queſtion. Some have ſuſpected that theſe fluids were propelled forwards principally by this attraction, but it is not neceſſary to admit ſuch a ſuppoſition, in order to explain the motion of the chyle, or of the lymph, becauſe the veſſels which convey theſe fluids are believed to have muſcular fibres, which being ſtimulated by the fluid may contract periſtaltically, and preſs the fluid forwards from one pair of valves to another.

The lymphatic ſyſtem is very full of theſe valves, much more ſo than the venous, and the reaſon of this difference ſeems to be, that the blood in the venous ſyſtem is ſtrongly preſſed forwards by the *vis a tergo* from the action of the heart and arteries, and therefore its courſe is leſs liable to be interrupted by any accidental preſſure. But the motion of the abſorbed fluid in theſe veſſels having no ſuch force, but only that of the attraction at the orifice, and the periſtaltic contraction of the coats, might eaſily be overcome by any lateral compreſſion, were it not for the valves, which ſeem to be given to prevent the retroceſſion of the lymph being conſiderable, and to make any lateral preſſure, inſtead of preventing, rather promote its paſſage to the heart: and as the lymphatic veſſels in the human ſubject not only accompany the arteries, but in many places paſs under them, when the courſe over them is as direct, it would ſeem probable, as ſome phyſiologiſts have ſuggeſted, that this was done in order that they may have the pulſation of ſuch arteries communicated to them, which pulſation, inconſiderable as it is, may rather promote the paſſage of the lymph.

CHAP. XIII.

Containing ſome Pathological Obſervations relating to the Lymphatic Syſtem.

THE fluids which lubricate the different cavities of the body are ſometimes collected in theſe cavities in an extraordinary quantity, and form dropſies, ſuch as the *aſcites*, *anaſarca*, dropſy of the *pericardium*, *thorax*, *tunica vaginalis*, *&c.*

In a former chapter we obſerved, when ſpeaking of the lymph that moiſtens ſuch cavities, that its properties vary in different circumſtances, and that in theſe dropſies the fluid that is let out by tapping is generally as thin as water, which inſtead of coagulating, when expoſed to heat, only becomes a a little turbid. Sometimes indeed it agrees with the ſerum of the blood in coagulating by heat, and ſometimes it flows from theſe cavities in a viſcid or ropey ſtate. In all theſe caſes the fluid occaſioning the dropſy is different from the fluid that naturally moiſtens thoſe cavities, which, in experiments related above, was found to agree with the coagulable lymph of the blood, in the circumſtance of jellying merely by expoſition to the air*.

Theſe circumſtances being conſidered, I think we may thence be led to a more correct notion about the cauſes of thoſe dropſies, which cauſes have been ſuppoſed to be either an increaſed ſecretion, or an impeded abſorption, or a rupture of the lymphatic veſſel; none of which probably, ſtrictly ſpeaking, gave riſe to ſuch morbid collections of water. For if merely an increaſed ſecretion, or an impeded abſorption was the cauſe of an *aſcites*, or an *anaſarca*, then the fluid let out ſhould reſemble that contained in theſe cavities in living animals. The ſame reaſoning holds good againſt theſe dropſies being occaſioned by the rupture of a lymphatic veſſel; that is, the fluid evacuated is not ſimilar to what we found contained in thoſe veſſels in our experiments, where the lymph jellied on expoſition to the air.

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* The water in the ventricles of the brain ſhould, I believe, be excepted, as I never ſaw it jelly, even when expoſed to heat.

And as we obſerved in thoſe experiments, that theſe fluids approached nearer to the nature of thoſe found in dropſies, in proportion as the animal was weakened, or reduced, as particularly in the dog fed eight days on bread and water; is it not therefore more probable, that in theſe kinds of dropſies there is ſomething more than an increaſed ſecretion, or an impeded abſorption? that is, there is a perverſion of the ſecretion, or the veſſels throw out a fluid different from the natural one: which may happen, either from the exhalant arteries being themſelves altered by diſeaſe, ſo as to change the properties of the fluid which paſſes through them; or from the maſs of blood being vitiated or abounding ſo much with water as to affect this ſecretion; thence theſe dropſies are not primary diſeaſes, but the conſequences of others; and a diſeaſed liver, ſpleen or lungs, which ſo often accompany theſe dropſies, are not ſo properly to be conſidered as giving riſe to them

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by cauſing a rupture of a lymphatic veſſel, or obſtructing the courſe of the lymph, as by affecting chylification and ſanguification; for when the liver, for example, is diſeaſed, and the bile deficient in quality or in quantity, the food not being properly aſſimilated, may make a bad blood, which may affect the veſſels, and may let go its water into theſe cavities.

But altho' from theſe conſiderations it ſeems probable, that an obſtruction or rupture of the lymphatics is not the cauſe of theſe dropſies, where a mere water is found in thoſe cavities, yet they may occaſionally be the cauſes of others. If a lymphatic ſhould burſt in a perſon in health, a dropſy may enſue; but the fluid would poſſeſs the properties which that lymph does naturally, and be either found coagulated, or would be capable of coagulation, when let out: the ſame may be obſerved of an increaſed ſecretion, or of an obſtruction of a lymphatic veſſel; the fluid would differ from mere water, and would either coagulate or be viſcid. Inſtances of ſuch fluids ſometimes occur in dropſies.

Thus a viſcid ropey fluid has been let out of the abdomen, not only in the dropſy of the *ovarium*, in which ſuch a fluid is commonly met with, but likewiſe ſometimes in the *aſcites* in men.

In like manner, the cellular membrane is ſometimes filled with a gelatinous fluid, which does not ooze out when the integuments are ſcarified, nor does it retain the impreſſion on being preſſed with the finger, as in the common *anaſarca*: this was remarkable in a woman that was in *St. George's Hoſpital* a few years ago, and who at the ſame time had an obſtruction of her menſes but no other ſymptom of ill health. The legs in this woman were ſwelled to twice their ordinary ſize, but did not pit on being preſſed with the finger. A caſe of the ſame ſort may now be ſeen in one of the nurſes at *St. Bartholomew*'s Hoſpital.

A ſimilar gelatinous fluid, is ſometimes ſeen upon cutting into tumours of the rheumatic kind near the ligaments of the joints; and Dr. *Lower* obſerved, that it was common to find the *pericardium* filled with a jelly in dead bullocks.

As we have remarked of a rupture of the lymphatic veſſels in an animal in health, that the fluid which eſcapes will coagulate; ſo we may obſerve of a wound of ſuch a veſſel, the lymph which oozes from it, if the perſon be in health, will not be a mere water, but will be like the coagulable lymph of the blood, in jellying on expoſition to the air, only a little later than the blood itſelf does, if we may judge from what is obſerved in Chap. 7. A caſe of this ſort I ſaw in a butcher, who by letting his knife fall upon his ſhin, cut ſome of the large lymphatic veſſels which paſs over the *tibia*, as repreſented at (*c c*) *Plate* 1ſt. From this wound there flowed a conſiderable quantity of a clear lymph, which, being confined by the dreſſings, jellied, and then, at firſt ſight, appeared like a whitiſh *fungus*, but being looſe could be removed with a *ſpatula*. Some caſes of wounds of lymphatics are related by the late Profeſſor *Monro**, who deſcribes a white *fungus* as apt to ariſe from them; and ſince ſeeing the caſe above mentioned, I cannot help ſuſpecting, that notwithſtanding the accuracy of that gentleman, he had met with a deception of this ſort. My patient, like his, was cured by tight preſſure, and lint dipped in a ſolution of vitriol.

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* Med. Eſſays, Vol V. Art. xxvii.

When a bliſter is applied to a perſon not much weakened by diſeaſe, as for example, behind the ear for the toothach, or to one who labours under a violent fever or an inflammation, we find on removing the cuticle, a ſerous fluid diſcharged. This fluid, I have found, coagulates by heat, exactly like the ſerum of the blood, or the white of an egg. After this ſerous fluid is let out from the bliſtered part, we ſometimes ſee over the inflamed ſkin, a white cruſt or jelly, which is eaſily removed, and ſeems to be the coagulable lymph of the blood, which has been thrown out by the inflamed exhalant arteries, and had jellied amidſt the ſerum. When this jelly is more condenſed, it appears not much unlike a ſecond cuticle*.

It is a fact univerſally admitted by phyſiologiſts, that all parts of the human body are bibulous, or imbibe fluids applied to them; thus garlick applied to the ſkin is ſoon ſmelt in the breath; and turpentine rubbed upon any part of the body ſoon gives to the urine a violet-like ſmell. In like manner, poiſonous ſubſtances are ſometimes taken into the conſtitution. The variolous matter, inſerted under the ſkin by the point of a lancet, produces the ſmall-pox; and the venereal matter, introduced by a chancre, occaſions the *lues venerea*. Theſe facts have been long known, but it is ſtill a queſtion by what channels theſe ſubſtances enter the body, whether by the common veins, which have moſt generally been ſuſpected to abſorb, or by the lymphatic veſſels.

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* In dropſical caſes the fluids diſcharged by bliſters are more watery.

How little probability there is of the common veins doing this office, has been obſerved above; but there are many circumſtances which prove that the lymphatic veſſels perform it; and there are ſome appearances in diſeaſes which cannot otherwiſe be well accounted for.

For example; after the inſertion of the variolous matter under the ſkin of the arm, in inoculation, before that matter enters the conſtitution ſo far as to produce any fever or eruption, the lymphatic glands in the *axilla* moſt frequently ſwell, or inflame; a ſtrong preſumption, that it is through the channel of the lymphatic ſyſtem that this poiſon enters the conſtitution.

After the application of the venereal matter to the genitals, where the ſkin is abraded, before the *lues venerea* is occaſioned, there is commonly an inflammation of the inguinal glands, which circumſtance renders it probable, that in this caſe too the poiſon enters by the lymphatic veſſels.

On the application of bliſters, we ſometimes find lymphatic glands ſwelling between the part inflamed by the bliſter and the heart*. Thus the axillary glands ſometimes become painful from a bliſter between the ſhoulders; and I once from this cauſe ſaw glands ſwell where they are not commonly met with on diſſection. It was in the caſe of my ingenious friend, Mr. H. Apothecary, who having applied a bliſter to his back, obſerved ſome ſmall ſwellings oppoſite to the inferior *coſta ſcapulæ,* he ſhewed them to me, and I told him they were glands inflamed in conſequence of an abſorption of a part of the cantharides, and would ſubſide on drying up the bliſter, which accordingly happened.

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* See Profeſſor Monro de Ven. Lym. Valv. p. 93.

It may be worth remarking, that theſe caſes of glands ſwelling in conſequence of the application of bliſters, furniſh the ſtrongeſt arguments in favour of the lymphatics being the inſtruments of abſorption; becauſe where a bliſter is applied, the ſkin is only inflamed and not eroded, ſo that if the acrid matter gets into the lymphatic ſyſtem, it can only be by abſorption. Whereas when the variolous matter is inſerted with a lancet, or the venereal matter enters from a chancre, we might queſtion whether it got into the lymphatics by abſorption or by an eroſion of the ſide of thoſe veſſels. But when the lymphatic glands ſwell in conſequence of a bliſter, it ſeems deciſive in favour of the poiſon entering the lymphatic ſyſtem, merely in conſequence of that ſyſtem being endowed with a power of imbibing whatever is applied to the ſurfaces of the body.

Poiſons which enter the conſtitution, beſides being diſcovered by their affecting the lymphatic glands, can ſometimes be traced by their effects on the lymphatic veſſels. A caſe of this ſort in conſequence of the bite of a gnat, was lately obſerved by my ingenious friend, Dr. *Maddocks*, Phyſician to the London Hoſpital. This patient, as Dr. *Maddocks* informs me, had been weeding in a garden, and had been bit near the root of her thumb, where a painful tumour appeared. Soon after which one of the axillary glands inflamed and ſwelled, and from the tumour of her thumb to the *axilla*, the aſcent of the matter could be traced by a painful ridge or cord, which went on the fore part of the *cubitus*, and inſide of the arm, exactly in the ſituation of the lymphatic veſſels painted in *Plate* vi, (g, h), one of which it ſeemed to be, inflamed in conſequence of the abſorption of the poiſonous matter.

I have likewiſe lately ſeen the gland juſt above the inner condyle of the *os humeri*, as is repreſented *Plate* vi, (d) ſwelled in conſequence of a wound and ſuppuration on the back of the middle finger.

In ulcers of the legs, the matter is ſometimes abſorbed and carried up the lymphatics, 'till it arrives at the glands in the groin, where it occaſions a *bubo*; which *bubo*, as has already been obſerved, * differs from the venereal one in being at the lower part of the groin, viz. in the glands, *f, f, Plate* 1.

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* See above, p. 24.

I have even ſeen the matter of an iſſue in the leg produce ſuch a bubo by abſorption, and in this caſe too the matter could be traced by a painful line in the inſide of the thigh in the courſe of the lymphatic veſſels, as repreſented in the ſame plate.

Matter formed in the joints, on being abſorbed, likewiſe produces ſuch buboes*

And milk which has ſtagnated in the breaſt creates a painful ſwelling in the axillary glands.

The axillary glands are likewiſe frequently obſerved to ſwell in conſequence of cancers in the breaſt*; and it is found to be of no uſe to extirpate the breaſt itſelf, unleſs the infected glands can likewiſe be removed; for otherwiſe the cancerous humour left in the glands may renew the diſeaſe: and indeed when theſe glands are affected in conſequence of a cancer, the operation of extirpation muſt be very precarious, as we can never be certain that the matter which has got ſo far as theſe glands may not alſo have got a little further, and have entered the conſtitution.

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* See Dr. Hunter's Medical Commentaries.

In cancers of the lips, the lymphatic glands under the angle of the lower jaw, and on the ſide of the neck, are apt to ſwell from the ſame cauſe, viz. the abſorption of the cancerous matter. And the like ſwellings may be produced by the abſorption of the venereal *virus* from ſores in the lips. I have ſeen theſe glands ſwell in conſequence of gum-boils, which frequently appear on the upper jaw, from the fang of a rotten tooth making its way thro' the jaw, and producing a ſuppuration that ſometimes burſts outwards, ſometimes into the ſocket of the tooth, and ſometimes diſappears without rupture; in which caſe I have ſeveral times ſeen the glands under the angle of the lower jaw ſwell and become painful, during the few days that the boil was diminiſhing.

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* Monro de Ven. Lymph Valv. p. 92.

In ſhort, wherever there is an eroſion or ulceration of the body attended with acrid matter, that matter is apt to be abſorbed, and in paſſing into the conſtitution commonly inflames the lymphatic glands which lie between the part eroded and the thoracic duct; a fact well deſerving the attention of the ſurgeon, who might otherwiſe take theſe glandular tumours for primary diſeaſes, and might expect to cure them without attending to the ulcers themſelves, but in vain; for being occaſioned by the abſorption of acrid matter, they will remain ſo long as the matter continues to be abſorbed: but that matter being once removed, theſe glandular tumours will generally ſubſide of courſe.

And moreover, as it frequently happens that theſe poiſons are not immediately abſorbed, but remain for ſome time in the wound before they enter the vaſcular ſyſtem, it gives us an opportunity of preventing the diſeaſe by cutting out the morbid fleſh, and thereby extirpating the poiſon before abſorption has taken place; a practice that has been uſed ſucceſsfully for the bite of a mad dog, and cannot be too ſtrongly recommended, as it ſeems to be the only certain way of preventing the ill conſequences of ſuch an injury. In thoſe caſes where the knife cannot be uſed, the application of the actual or potential cauteries has been recommended; for theſe cauteries, by deſtroying the poiſonous matter, and the parts which it has already tainted, may preſerve the conſtitution from the infection. It is alſo probable, that the venereal poiſon might be prevented from entering the conſtitution, if immediately upon the appearance of a chancre the patient would ſubmit to the exciſſion of that chancre, or to have a cauſtic applied to it. In like manner, ſince it is known that when the cancerous matter is once generated, whether in the *mamma*, *teſtis*, or any other gland, that ſuch matter, on being abſorbed, will infect the other parts of the body; is it not therefore a ſtrong argument in favour of the early extirpation of cancers, that the longer they are ſuffered to remain, the more probability there will be of the cancerous humour being taken up by the abſorbents, and ſpreading the infection?

As the lymphatic veſſels paſs thro' the lymphatic glands in their way to the thoracic duct, when theſe glands are obſtructed, the lymph, not being able to get into that duct, is retained in the extremities; thence we ſo often ſee dropſies the conſequences of diſeaſed lymphatic glands; which dropſies cannot be cured till the obſtruction of the gland be removed. But as I have already obſerved, the lymphatic veſſels do not conſtantly paſs through glands but ſome of them paſs by their ſides; thence it is poſſible that a gland may be perfectly obſtructed, and yet the lymph may get by the collateral branch of a lymphatic into the thoracic duct, and not be retained in the extremity ſo as to occaſion a dropſy or *œdema.* In like manner a gland may be perfectly eroded, or may be cut out, ſometimes, without the lymph being thereby prevented getting into the thoracic duct. And it may alſo happen, that the venereal, or other poiſon, may, upon being abſorbed, paſs into the conſtitution by one of theſe lateral branches without entering a lymphatic gland or inflaming it. That this is probable the reader may believe, upon looking over the plates, particularly (*Plate* III.) where the mercury appears to have paſſed from the groin the whole length of the trunk without entering a lymphatic gland. From which fact may be underſtood, how the venereal poiſon ſometimes enters the conſtitution, and produces the *lues* without occaſioning a *bubo*, an inſtance of which I ſaw lately. And the variolous matter introduced by inoculation, although frequently producing inflammation and ſwelling of the lymphatic glands, yet is not always attended with thoſe ſymptoms: to which may be added, that another reaſon why theſe poiſons do not conſtantly affect the lymphatic glands in their way into the body, may be the leſſened ſenſibility of theſe glands in ſome particular caſes: whence the ſame poiſon which at one time would have produced the worſt effects, may at another paſs through theſe glands without inflaming them.

And laſtly, not only obſtructed lymphatic glands ſometimes occaſion dropſies, but alſo whatever impedes the paſſage of the lymph into the veins; whether it be a thickening of the coats of the jugular or ſubclavian veins near the termination of the thoracic duct, or a tumour of the aneuryſmal, ſchirrhous, or encyſted kind, contiguous to any part of the lymphatic ſyſtem; for ſuch tumour, by compreſſing the lymphatic veſſels, may prevent the return of the lymph, and may thereby occaſion a dropſy or *œdema* of the parts from which theſe veſſels originated.

Upon the whole, whoever carefully views the lymphatic ſyſtem muſt be convinced, that as it explains, and points out the cure of many diſeaſes, it deſerves the attention of the practitioners of the healing art. And as it is ſo generally diffuſed through the animal kingdom, it ſtrongly claims the regard of thoſe who wiſh to inquire philoſophically into the animal œconomy, my, eſpecially, as by the knowledge of this ſyſtem, we are now flattered with the hopes of aſcertaining the uſe of the lymphatic glands, the thymus, and the ſpleen; which diſcoveries are to be the ſubjects of the third part of theſe inquiries.

PLATE I.

Exhibits the more ſuperficial Lymphatic Veſſels of the lower Extremity.

A	The ſpine of the *os illium*
B	The *os pubis*
C	The illiac artery
D	The knee
E,E,F	Branches of the crural artery
G	The *muſculus gaſtrochnemius*
H	The *tibia*
I	The tendon of the *muſculus tibialis anticus.*

On the Out-lines.

a	A lymphatic veſſel belonging to the top of the foot
b	Its firſt diviſion into branches

c,c,c Other diviſions of the ſame lymphatic veſſel.

d A ſmall lymphatic gland

e The lymphatic veſſels which lie between the ſkin and the muſcles of the thigh.

f,f Two lymphatic glands at the upper part of the thigh below the groin.

g,g Other glands

h A lymphatic veſſel which paſſes by the ſide of thoſe glands without communicating with them; and, bending towards the inſide of the groin at (i), opens into the lymphatic gland (k)

l,l Lymphatic glands in the groin, which are common to the lymphatic veſſels of the genitals and thoſe of the lower extremity.

m,n A plexus of lymphatic veſſels paſſing on the inſide of the illiac artery.

N. B. The lymphatic veſſels appear in theſe plates more regularly cylindrical than they are repreſented by *Nuck*, *Ruyſch* and others, in whoſe plates ſuch veſſels are painted more like chains of veſicles than I have ever ſeen them.

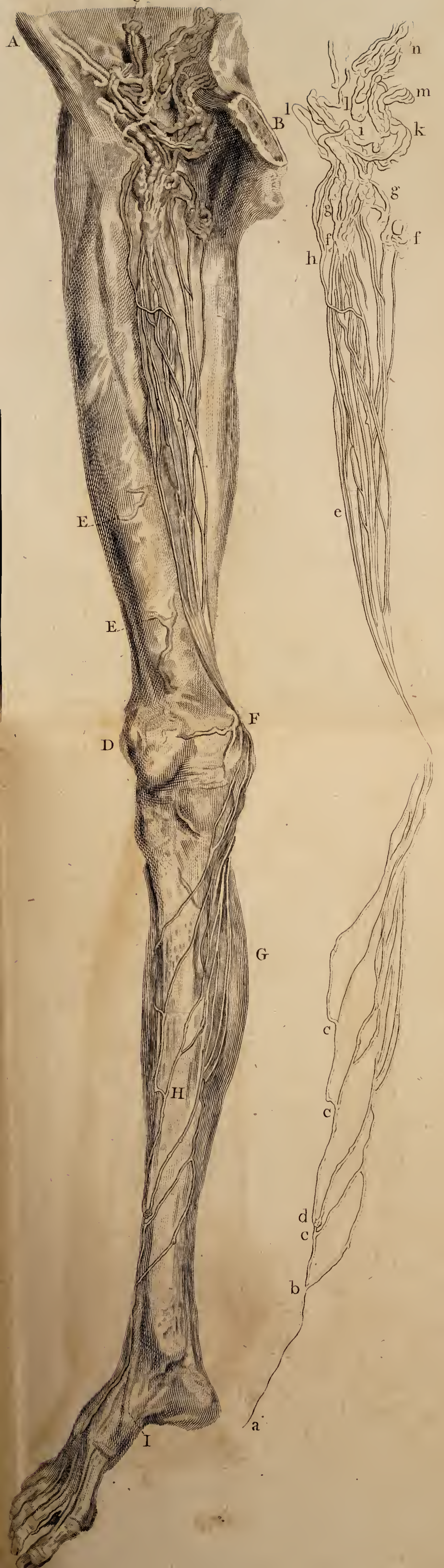
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PLATE II.

Exhibits a back View of the lower Extremity, diſſected ſo as to ſhew the deeper ſeated Lymphatic Veſſels which accompany the Arteries.

N. B. This extremity was dried before the plate was made from it, and the muſcles are therefore much ſhrunk.

A The *os pubis*

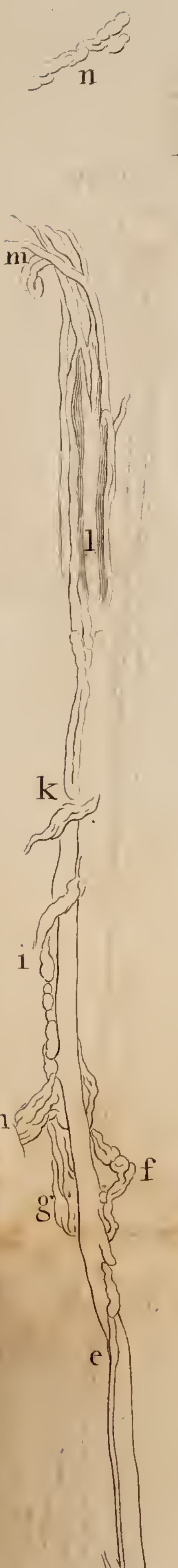
B The tuberoſity of the *iſchium*

C That part of the *os illium* which was articulated with the *os ſacrum*

D The extremity of the illiac artery appearing above the groin

E The knee

F,F The two cut ſurfaces of the *triceps* muſcle, which was divided to ſhew the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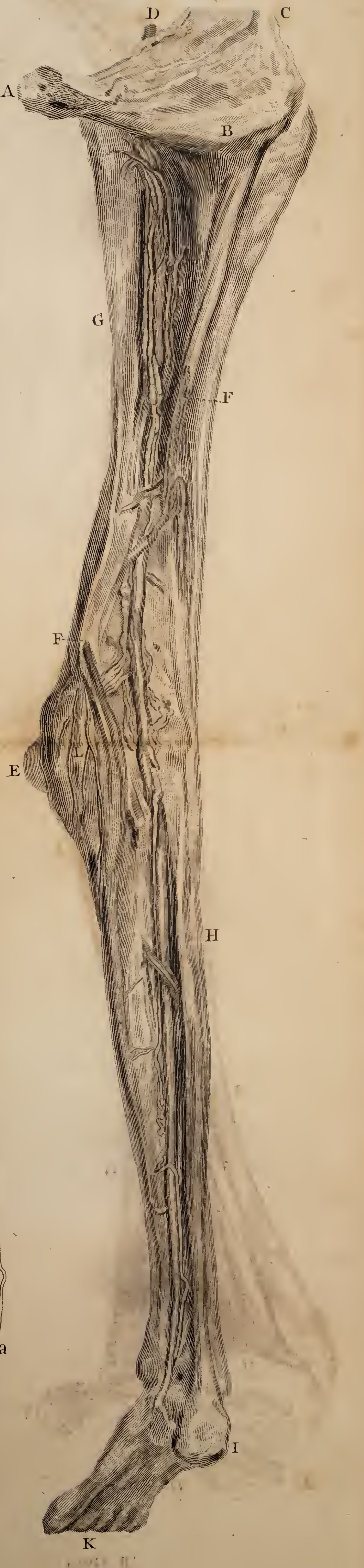
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the lymphatic veſſels that paſs thro' its perforation along with the crural artery.

G	The edge of the *muſculus gracilis*
H	The *gaſtrochnemius* and *ſoleus*, much ſhrunk by being dried, and by the *ſoleus* being ſeparated from the *tibia* to expoſe the veſſels.
I	The heel
K	The ſole of the foot
L	The ſuperficial lymphatic veſſels paſſing over the knee, to get to the thigh.

On the Out-lines.

M	The poſterior tibial artery
a	A lymphatic veſſel accompanying the poſterior tibial artery
b	The ſame veſſel croſſing the artery
c	A ſmall lymphatic gland, through which this deep ſeated lymphatic veſſel paſſes.

d The lymphatic veſſel paſſing under a ſmall part of the *ſoleus* which is left attached to the bone, the reſt being removed.

e The lymphatic veſſel croſſing the popliteal artery

f,g,h Lymphatic glands in the ham, through which the lymphatic veſſel paſſes.

i The lymphatic veſſel paſſing with the crural artery through the perforation of the *triceps* muſcle.

k The lymphatic veſſel, after it has paſſed the perforation of the *triceps*, dividing into branches which embrace the artery (l).

m A lymphatic gland belonging to the deep ſeated lymphatic veſſel. At this place thoſe veſſels paſs to the fore part of the groin, where they communicate with the ſuperficial lymphatic veſſels.

n A part of the ſuperficial lymphatic veſſels appearing on the brim of the *pelvis.*

PLATE III.

Exhibits the Trunk of the Human Subject, prepared to ſhew the Lymphatic Veſſels and the Ductus Thoracicus.

A The neck

B,B The two jugular veins

C The *vena cava* ſuperior

D,D,D,D The ſubclavian veins

E The beginning of the *aorta* pulled to the left ſide by means of a ligature, in order to ſhew the thoracic duct behind it.

F The branches ariſing from the curvature of the *aorta*.

G,G The two carotid arteries

H,H The firſt ribs

I,I The *trachea*

K,K The ſpine

L,L The *vena azygos*

M,M The deſcending *aorta*

N	The cœliac artery dividing into three branches.
O	The ſuperior meſenteric artery
P	The right *crus diaphragmatis*
Q,Q	The two kidnies
R	The right emulgent artery
S,S	The external illiac arteries
g,d	The *muſculi pſoæ*
T	The internal illiac artery
U	The cavity of the *pelvis*
X,X	The ſpine of the *os illium*
Y,Y	The groins
a	A lymphatic gland in the groin, into which lymphatic veſſels from the lower extremity are ſeen to enter*.
b,b	The lymphatic veſſels of the lower extremities paſſing under pouparts ligament.
c,c	A plexus of the lymphatic veſſels lying on each ſide of the *pelvis*.
d	The *pſoas* muſcle with lymphatic veſſels lying upon its inſide.

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* The letters are very ſmall on this plate, that it might be leſs disfigured by them.

e A *plexus* of lymphatics, which having paſſed over the brim of the *pelvis* at (*c*), having entered the cavity of the *pelvis,* and received the lymphatic veſſels belonging to the *viſcera* contained in that caty; next aſcends, and paſſes behind the illiac artery to (*g*).

f Some lymphatic veſſels of the left ſide paſſing over the upper part of the *os ſacrum*, to meet thoſe of the right ſide.

g The right *pſoas*, with a large *plexus* of lymphatics lying on its inſide.

h,h The *plexus* lying on each ſide of the ſpine.

i,i,i Spaces occupied by the lymphatic glands.

k The trunk of the lacteals lying on the under ſide of the ſuperior meſenteric artery.

l The ſame dividing into two branches, one of which paſſes on each ſide of the *aorta*; that of the right ſide being ſeen to enter the thoracic duct at (*m*).

m The thoracic duct beginning from the large lymphatics.

n The duct paſſing under the lower part of the *crus diaphragmatis* and under the right emulgent artery.

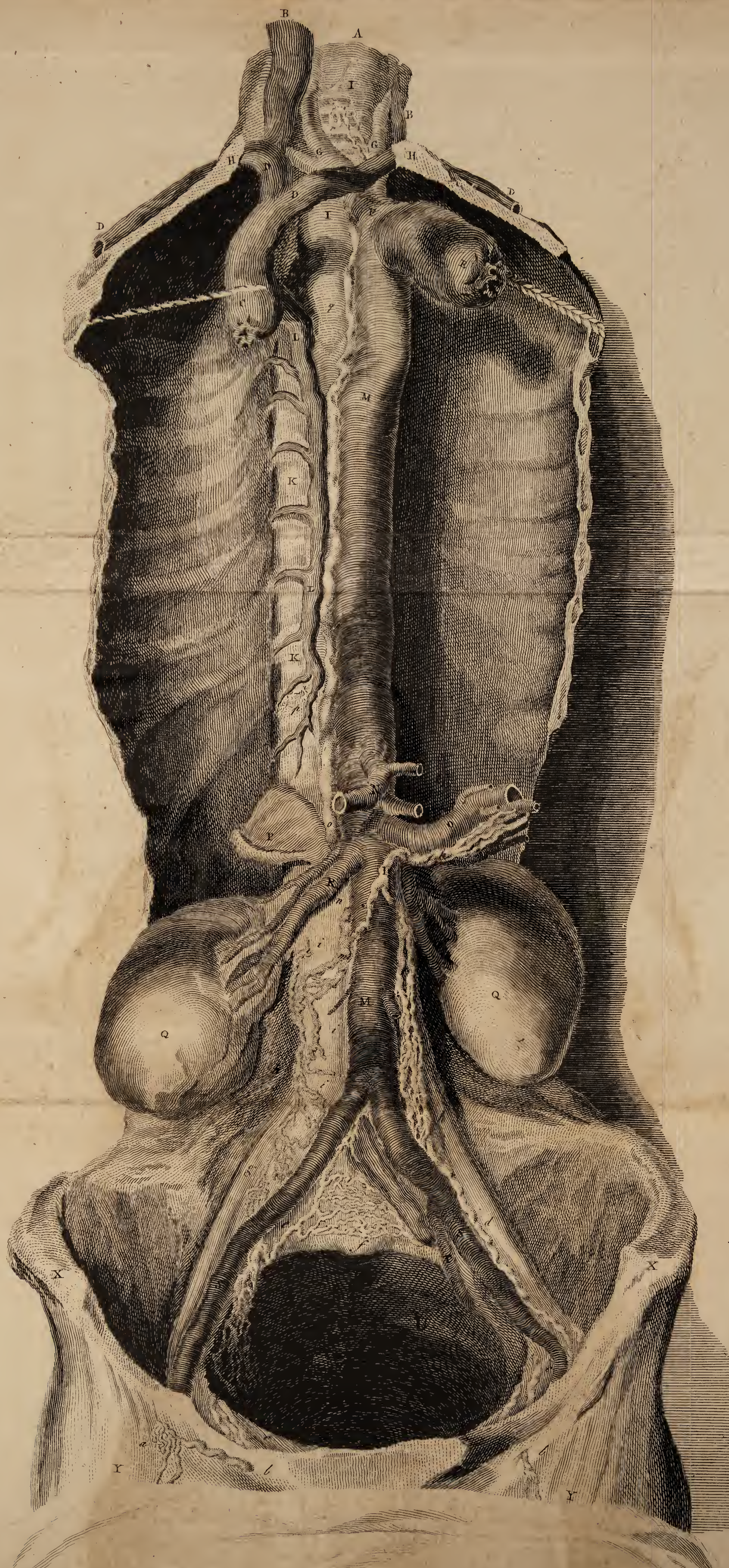
o The thoracic duct penetrating the *thorax*.

p Some lymphatic veſſels joining that duct in the thorax.

q The thoracic duct paſſing under the curvature of the aorta to get to the left ſubclavian vein. The *aorta* being drawn aſide to ſhew the duct.

r A *plexus* of lymphatic veſſels paſſing upon the *trachea* from the thyroide gland to the thoracic duct.

Plate III.



T. Bonnor del.t et sculp.

PLATE IV.

A	The neck
B,B	The two ſhoulders with the pectoral muſcles turned over them
C,C	The arms
D,D	The cut ends of the clavicles
E,E	The extremities of the two firſt ribs
F,F	The ſubclavian muſcles
G,G	The ribs
H	The *trachea*
I	The *aorta aſcendens*

On the Out-lines.

K	The *aorta deſcendens*
L	The trunk of the carotid, and ſubclavian artery of the right ſide
M	The left carotid
N,N	The left ſubclavian artery

O	The *cava ſuperior*
P	The trunks of the ſubclavian and jugular veins
Q	The right ſubclavian vein
R	The right jugular vein
S	The left ſubclavian vein
T	The left jugular
a	The thoracic duct paſſing on the right ſide of the deſcending *aorta* (K), behind the aſcending *aorta* (I), and behind the lower part of the left carotid artery (M), and then appearing at (*b*).
b	The upper part of the thoracic duct lying betwen the left carotid and the left jugular vein, and paſſing behind that vein downwards and outwards towards the angle between the left jugular and the left ſubclavian.
c	The extremity of the thoracic duct entering the angle between the left jugular and the left ſubclavian vein.

d,d Two of the trunks of the lymphatics of the left arm lying upon the outſide of the cheſt, and paſſing under the ſubclavian muſcle F, *(ſee the figure)* and the ſubclavian vein S, the clavicle itſelf being removed, and its cut extremity ſeen at D, upon the figure.

e A trunk formed by the lymphatics of the upper extremity, which trunk joins the extremity of the thoracic duct (*c*), and enters the angle between the left jugular and the left ſubclavian vein.

f Lymphatics from the thyroide gland running upon the *trachea*, and paſſing under the *aorta* to get to the thoracic duct, juſt where that duct enters the veins.

g,g A trunk of the lymphatics of the right arm lying on the outſide of the right brachial artery.

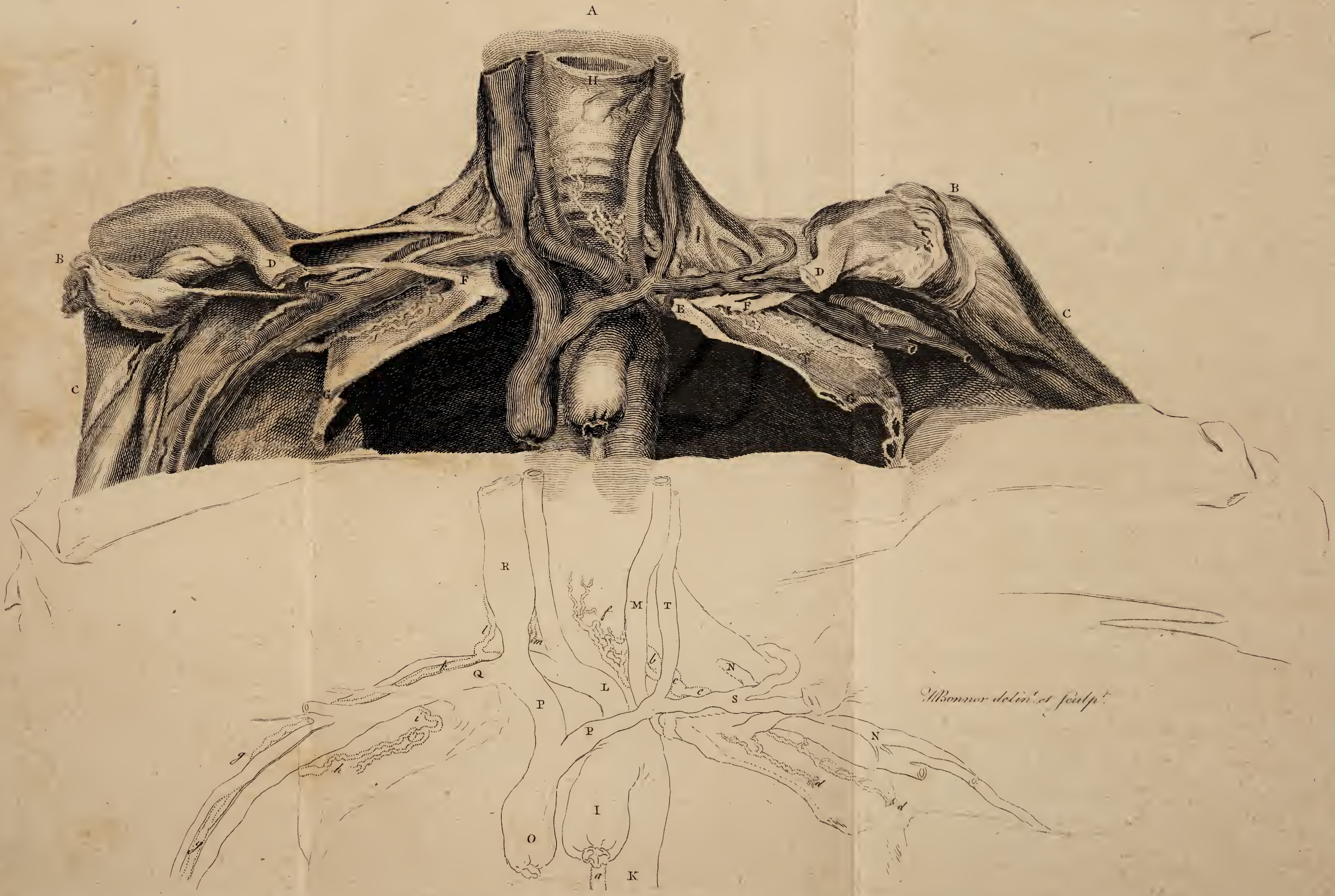
h A branch of this trunk making a net-work on the outſide of the *thorax* juſt under the clavicle.

i That network paſſing under the right ſubclavian vein (Q) and under the ſubclavian muſcle F, (on the figure) the clavicle itſelf being removed.

k The common trunk both of that *plexus* and of all the other lymphatics of the upper extremity of the right ſide, which trunk lies between the right ſubclavian artery and vein, and paſſes into the angle between the right jugular and the right ſubclavian.

l The trunk of the lymphatics of the right ſide of the neck lying on the outſide of the right jugular vein, and paſſing into the angle between that vein and the ſubclavian of the ſame ſide.

m One of the lymphatics of the right ſide of the thyroide gland going under the right jugular vein.



W.Bonnor delint. et ſculpt.

PLATE V.

Exhibits a back View of the fore Arm and Hand. The Preparation from which this View was taken having been previouſly dried, the Muſcles appear very ſlender.

A	The hand
B	The lower extremity of the *radius*
C	The lower extremity of the *ulna*
D	The muſcles on the back of the fore arm turned aſide to exhibit a deep ſeated lymphatic veſſel, which perforates the interoſſeous ligament to get to the fore part.
E	The *olecranon*

On the Out-Lines.

a,a,a Lymphatics appearing on the back of the fore arm immediately under the ſkin.

b Some of the lymphatics bending over the upper extremity of the *radius* to get to the fore part of the arm.

c A lymphatic paſſing over the *ulna*, immediately under the *olecranon*, and under the inner condyle of the *os humeri*, to get to the fore part of the arm.

d A lymphatic which has penetrated the muſcles, perforates the interoſſeous ligament, and gets to the fore part of the arm near the radial artery.

Plate V.

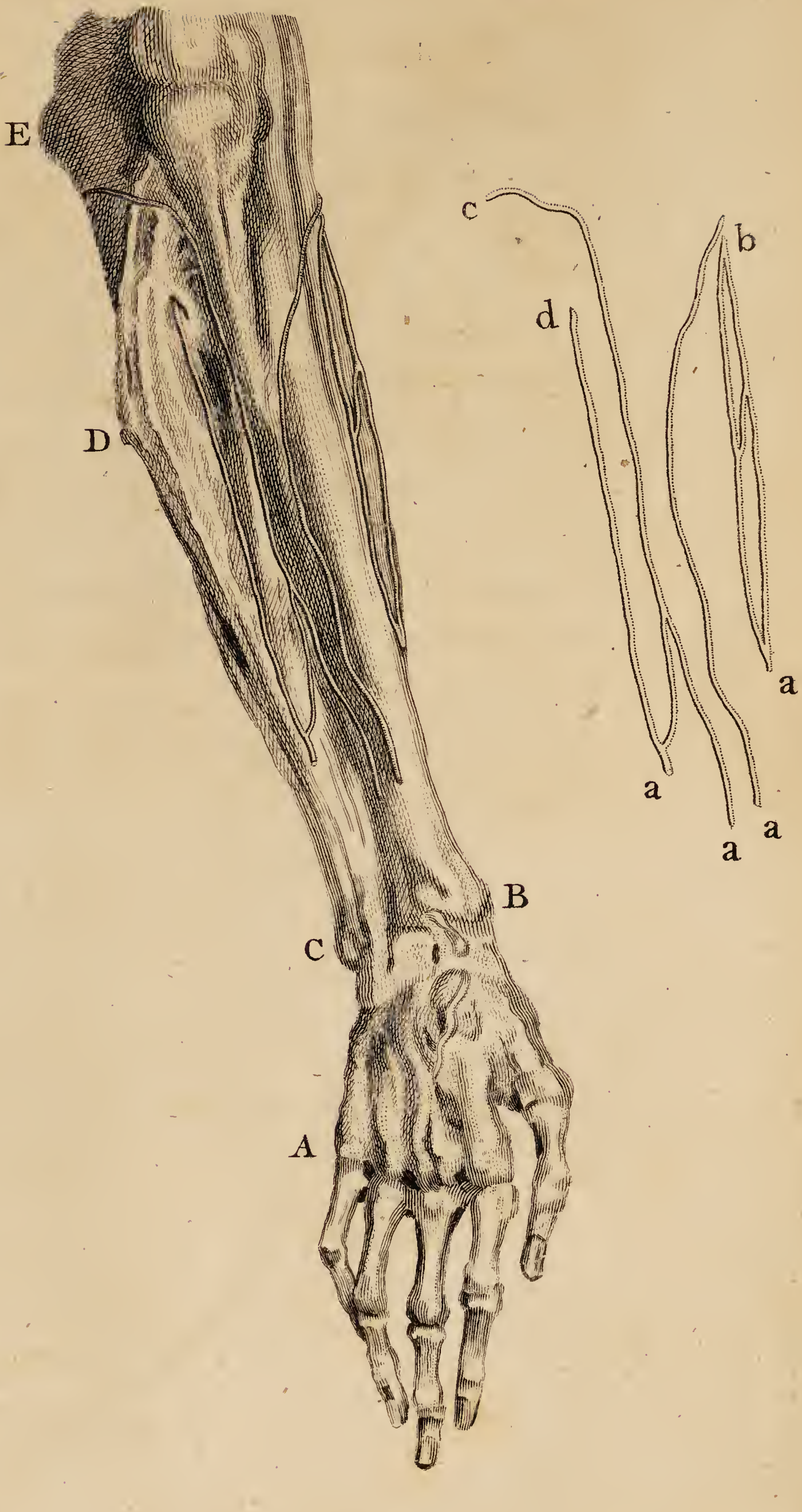


PLATE VI.

Exhibits a fore View of the upper Extremity. This Plate was likewiſe made from a dried Preparation, and the Muſcles therefore appear very ſmall. It has a peculiarity in the ulnar Artery running over the Muſcles inſtead of under them.

A	The *ſcapula*
B	The clavicle
C	The extremity of the brachial artery
D	The muſcles lying on the inſide of the arm
E	The inner condyle of the *os humeri*
F	The lower extremity of the *radius*

On the Out-Lines.

a A lymphatic veſſel which lies in the cellular membrane immediately under the ſkin, and paſſes up on the inſide of the arm to the axillary glands.

b Superficial lymphatic veſſels paſſing over the muſcles from the back of the fore arm, and likewiſe over the *biceps* to the glands in the *axilla.*

c A ſuperficial lymphatic from the back of the fore arm.

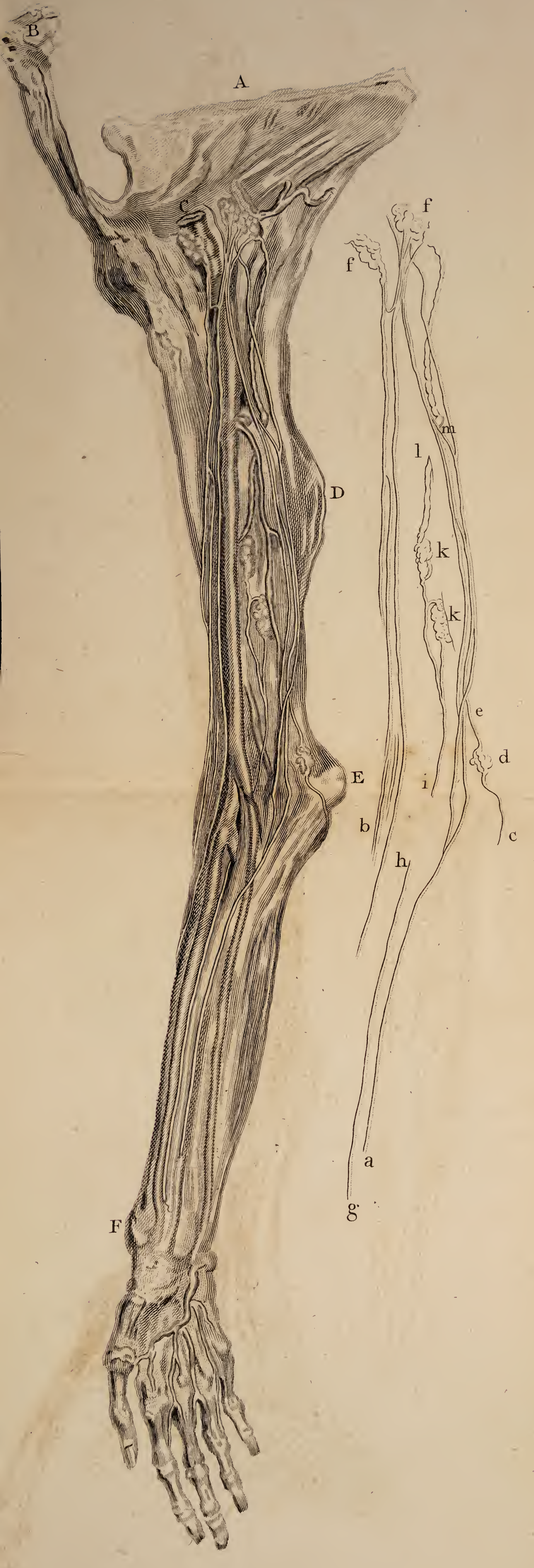
d A gland through which it paſſes.

e The lymphatics from the anterior and the poſterior part of the fore arm uniting.

f,f Lymphatic glands in the *axilla.*

g A deeper ſeated lymphatic veſſel lying cloſe to the radial artery which it accompanies all the way to (h).

h The deep ſeated lymphatic veſſel paſſing under the interoſſeous and ulnar arteries, and appearing again on the arm at (i).


B
A
C
f
f
m
l
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E
i
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b
h
a
g
F

i The deep ſeated lymphatic veſſel lying cloſe to the brachial artery.

k,k Two ſmall lymphatic glands thro' which it paſſes.

l The ſame veſſel now become much larger and paſſing under a branch of the artery and ſome cellular membrane, and appearing at (m).

m The trunk of the deep ſeated lymphatic veſſels paſſing upwards to the *axilla*, where it enters the glands, f,f.

f,f Three axillary glands, which are common both to the ſuperficial and the deep ſeated lymphatic veſſels.

THE END.